US006796186B2

(12) **United States Patent**
**Lia et al.**

(10) **Patent No.: US 6,796,186 B2**
(45) **Date of Patent: Sep. 28, 2004**

(54) **BLOOD PRESSURE MEASURING DEVICE WITH DIRECTLY COUPLABLE MEASUREMENT MECHANISM**

(75) Inventors: **Raymond A. Lia**, Auburn, NY (US); **Robert L. Vivenzio**, Auburn, NY (US)

(73) Assignee: **Welch Allyn, Inc.**, Skaneateles Falls, NY (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/608,202**

(22) Filed: **Jun. 27, 2003**

(65) **Prior Publication Data**

US 2004/0083816 A1 May 6, 2004

**Related U.S. Application Data**

(60) Division of application No. 09/929,501, filed on Aug. 14, 2001, now Pat. No. 6,615,666, which is a continuation-in-part of application No. 09/669,474, filed on Sep. 25, 2000, now Pat. No. 6,422,086.

(51) **Int. Cl.**[7] ..... **G01L 7/00**
(52) **U.S. Cl.** ..... **73/756**
(58) **Field of Search** ..... 73/715–727, 756; 600/485–488

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 1,106,341 | A | 8/1914 | Bristol | |
| 1,328,876 | A | 1/1920 | Hill | |
| 1,377,032 | A | 5/1921 | Starling et al. | |
| 2,087,494 | A | 7/1937 | Annin | |
| 2,341,137 | A | 2/1944 | Damron | |
| 2,564,669 | A | 8/1951 | Brady | |
| 2,636,394 | A | 4/1953 | Melchior | |
| 3,797,315 | A | 3/1974 | Halpern | |
| 3,805,618 | A | 4/1974 | Csaposs et al. | |
| 3,874,242 | A | 4/1975 | Csaposs et al. | |
| 4,036,061 | A | 7/1977 | Speidel | |
| 4,040,298 | A | 8/1977 | Lee et al. | |
| 4,255,970 | A | 3/1981 | Van Pottelberg | |
| 4,543,824 | A | 10/1985 | Marterer | |
| 4,685,336 | A | 8/1987 | Lee | |
| 5,181,422 | A | 1/1993 | Leonard et al. | |
| 5,753,821 | A | 5/1998 | Chou | |
| 5,966,829 | A | 10/1999 | Lia et al. | |
| 6,120,458 | A | 9/2000 | Lia et al. | |
| 6,168,566 | B1 | 1/2001 | Lia et al. | |
| 6,213,953 | B1 * | 4/2001 | Reeves | 600/499 |
| 6,234,972 | B1 * | 5/2001 | Lia et al. | 600/485 |
| 6,615,666 | B1 * | 9/2003 | Lia et al. | 73/715 |

FOREIGN PATENT DOCUMENTS

| | | |
|---|---|---|
| DE | 0 591 564 A1 | 10/1992 |
| EP | 0 705 563 A | 4/1996 |
| FR | 2592297 A | 7/1987 |
| WO | 00 22983 A | 4/2000 |
| WO | 00/40941 | 7/2000 |

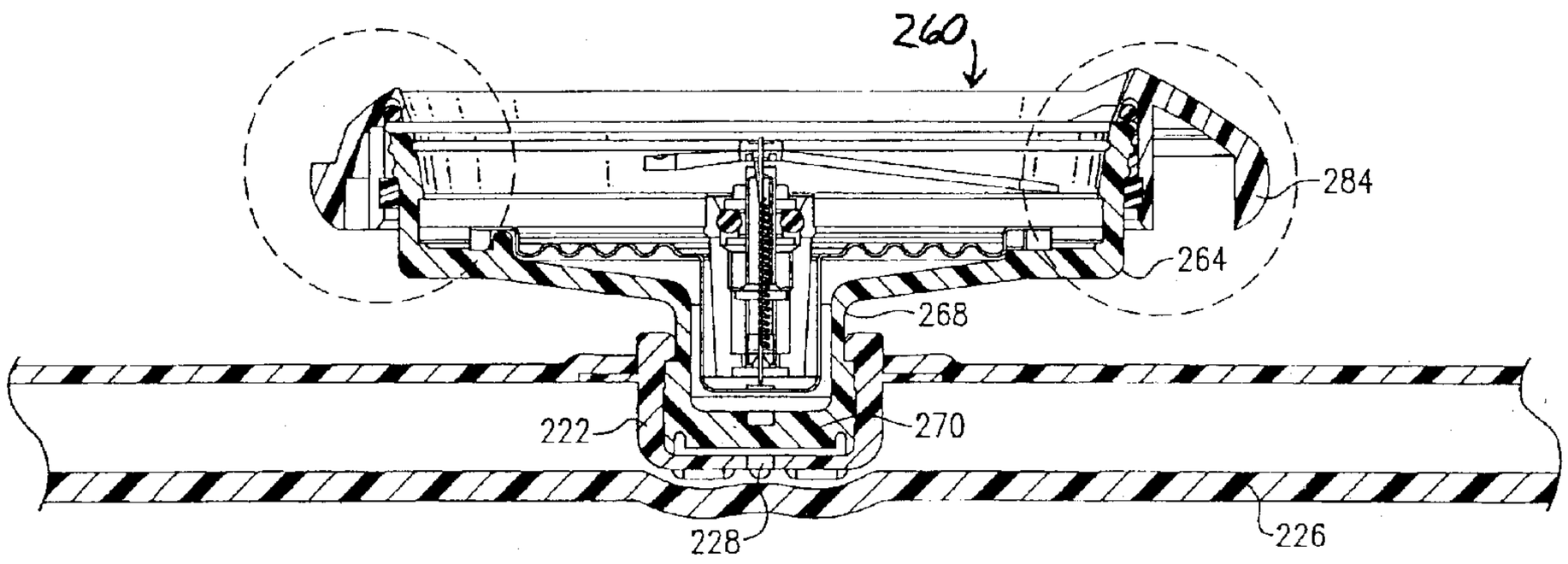
* cited by examiner

*Primary Examiner*—William Oen
(74) *Attorney, Agent, or Firm*—Wall Marjama & Bilinski LLP

(57) **ABSTRACT**

A pressure measuring device includes a housing which retains a pressure responsive element interconnected to an indicating member that moves relative to a dial face when a change of pressure is detected. A peripheral bumper is mounted to the housing exterior, the bumper including an extending portion which creates a discontinuous path for shock or impact loads applied to the bumper relative to a continual movement mechanism. The housing can further include a discontinuous region imposed in an engagement portion of the housing, the engagement portion permitting the housing to be directly attached to an inflatable blood pressure sleeve.

**13 Claims, 13 Drawing Sheets**



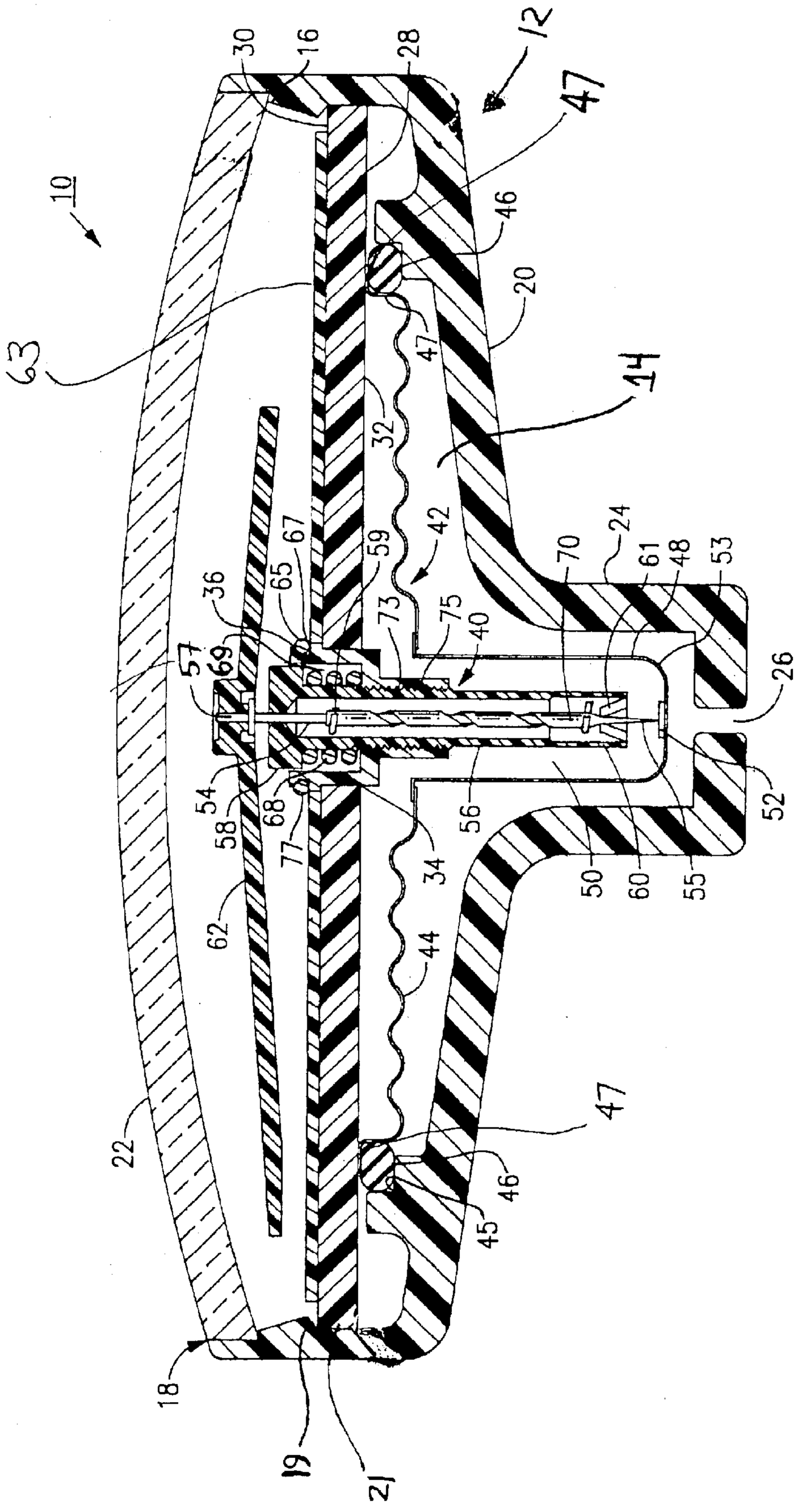

30
16
28
12
47
10
46
20
63
47
14
32
42
24
70
61
48
53
67
59
65
36
73
75
40
57
69
26
54
58
68
77
56
52
34
50
60
55
62
44
22
47
46
45
18
19
21

FIG.1

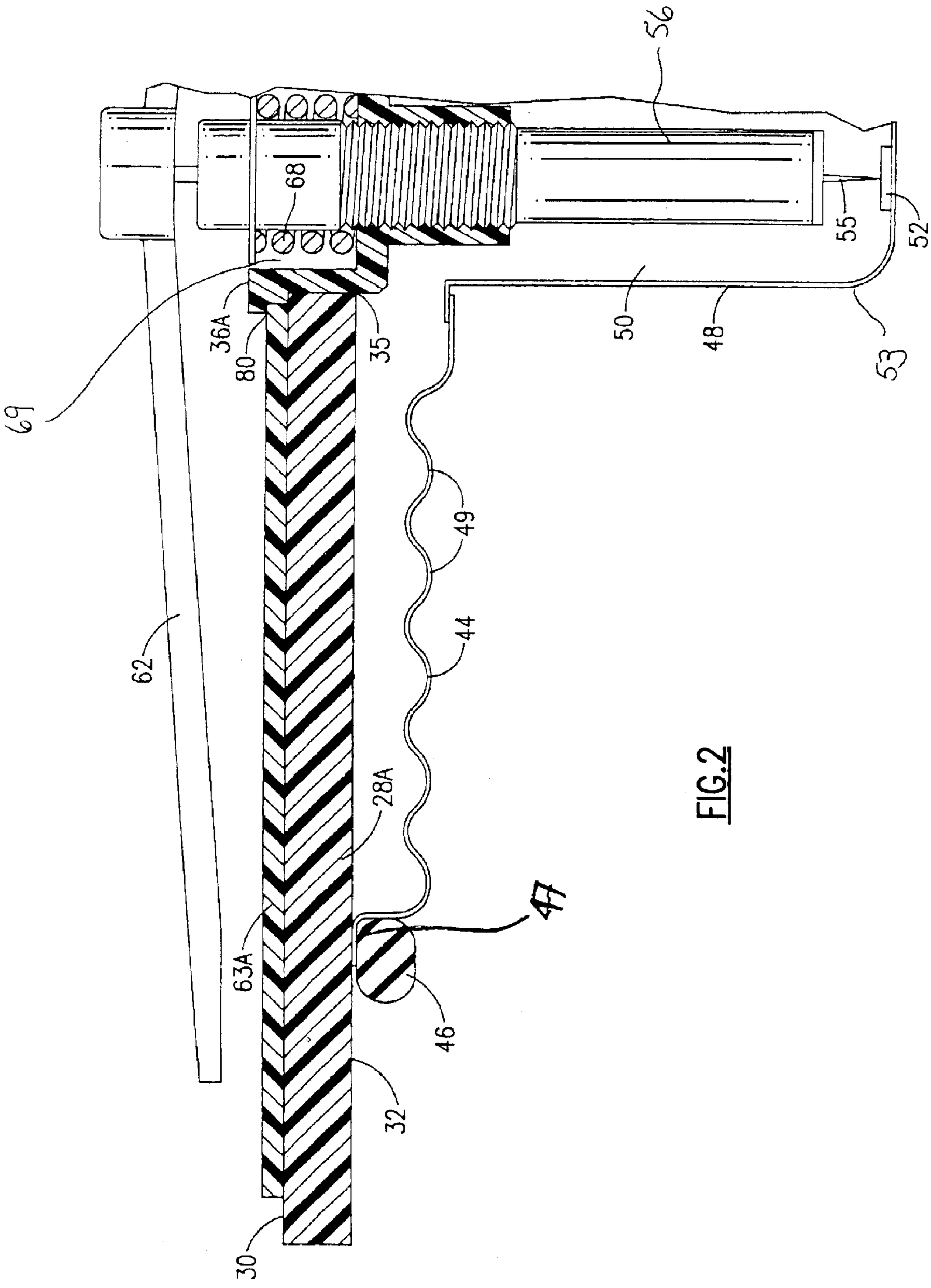



FIG.2

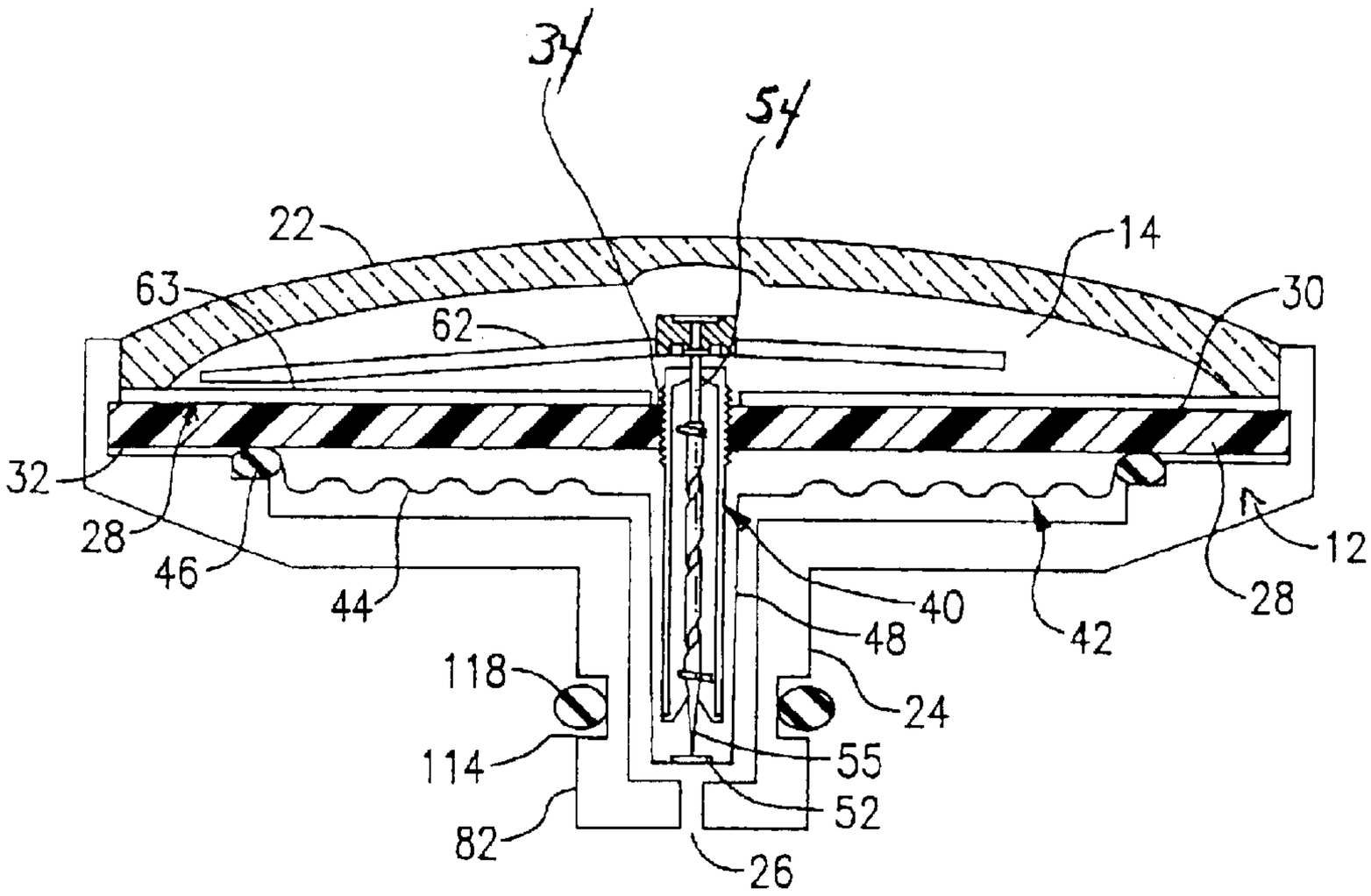

34
54
22
14
63
62
30
32
28
46
44
40
48
42
28
12
118
24
114
55
52
82
26

FIG.3

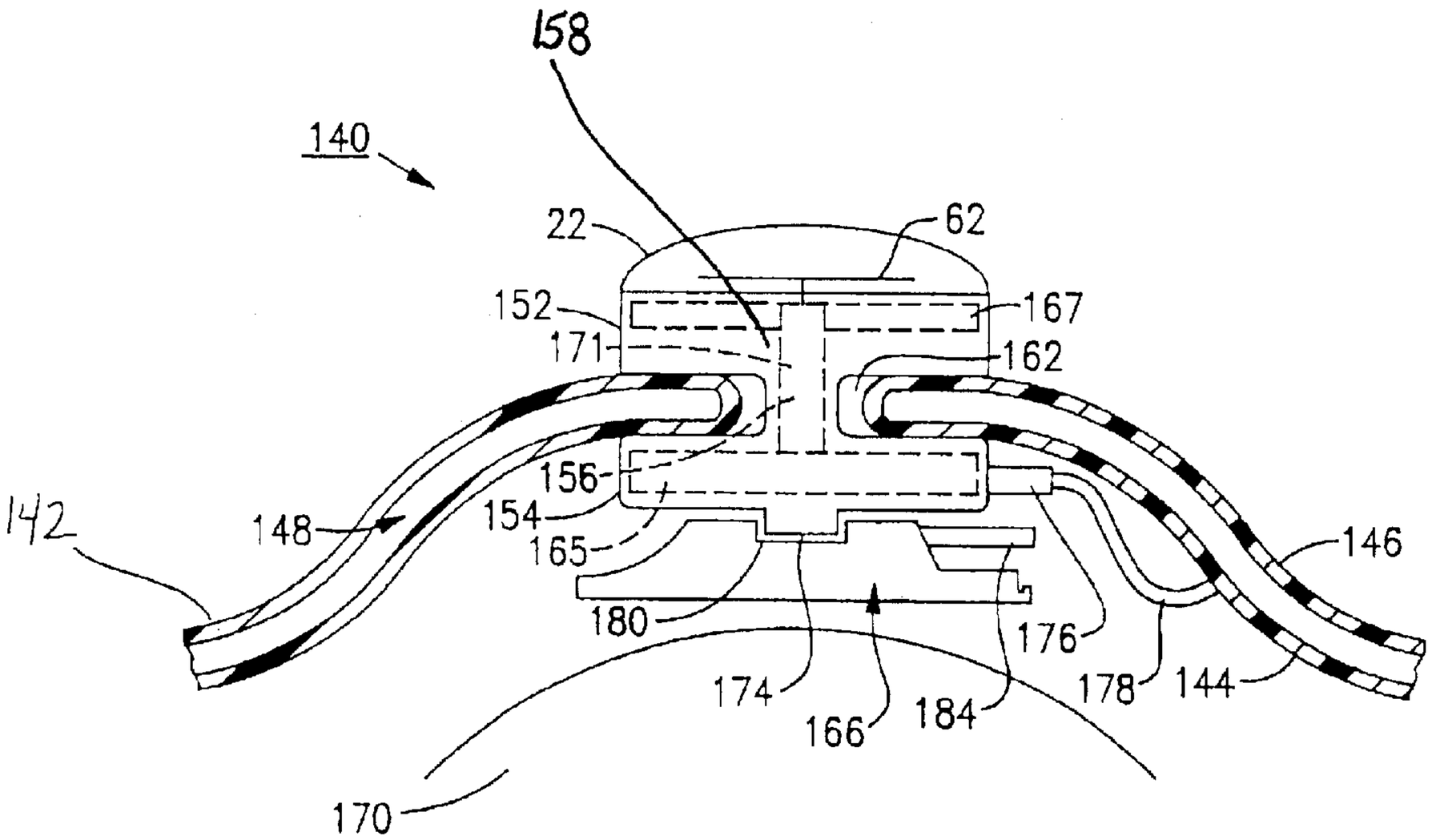

158
140
22
62
152
167
171
162
156
154
165
148
142
146
180
176
174
166
184
178
144
170

FIG.5

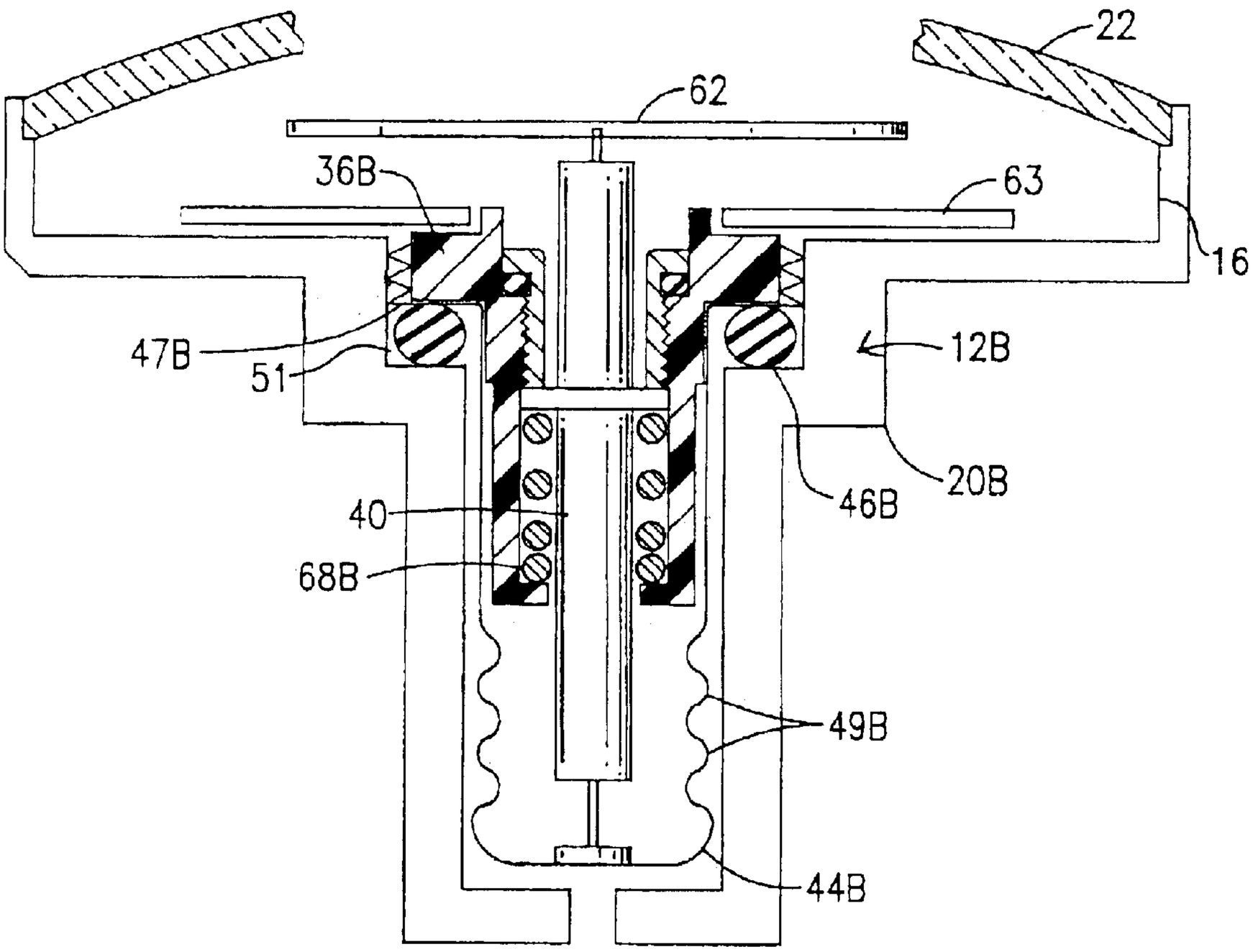



FIG.4

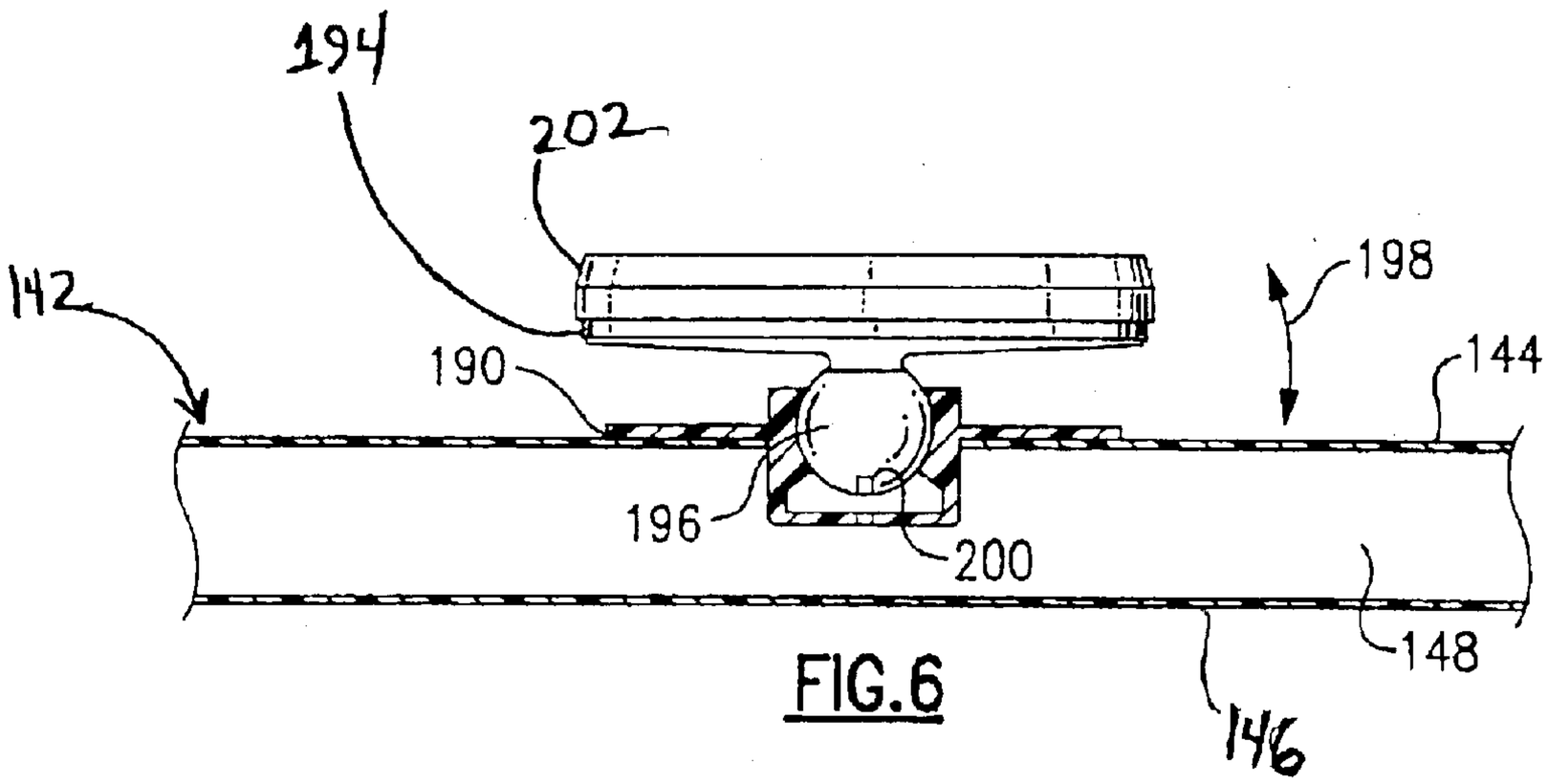



FIG.6

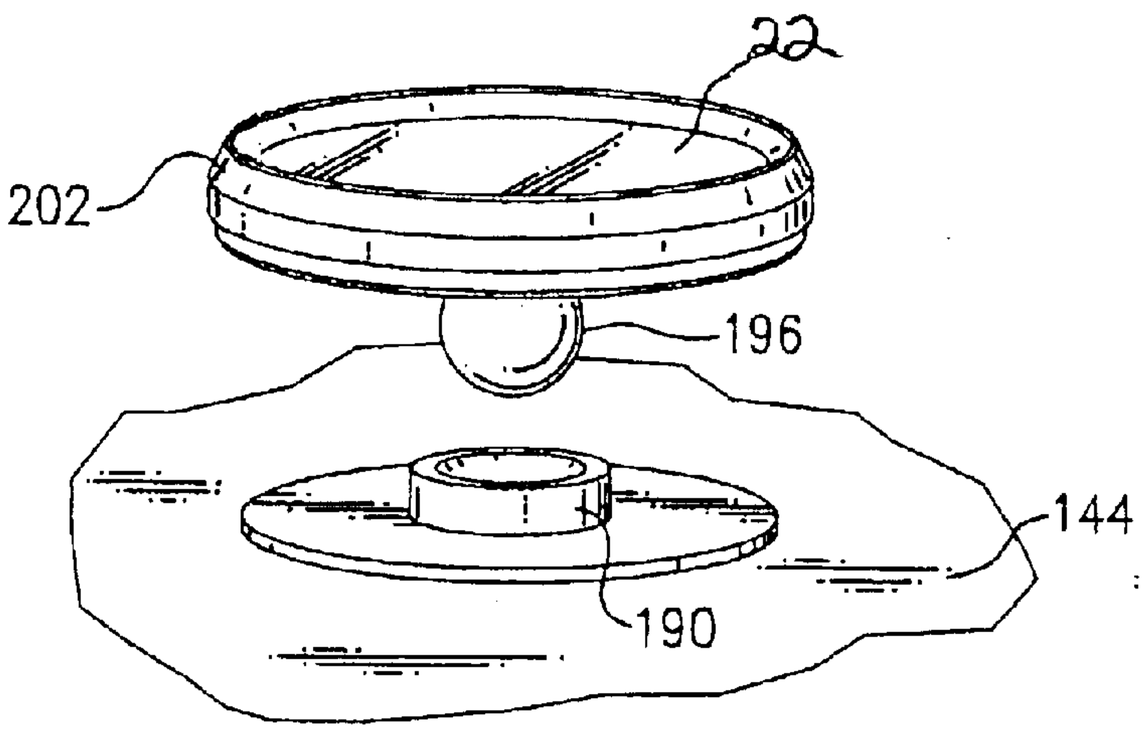



FIG.7

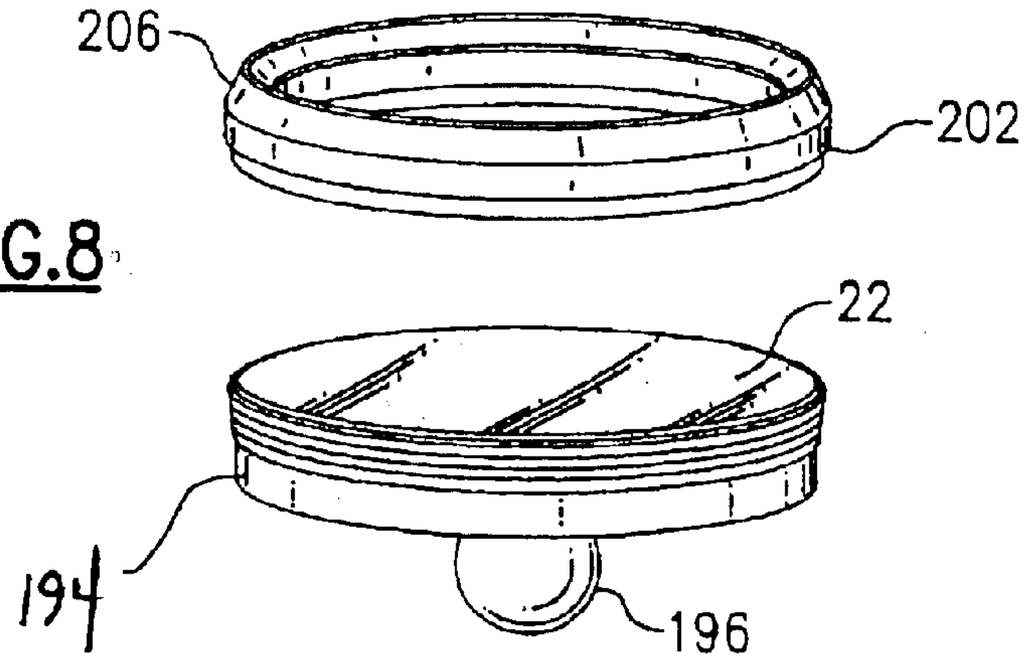



FIG.8

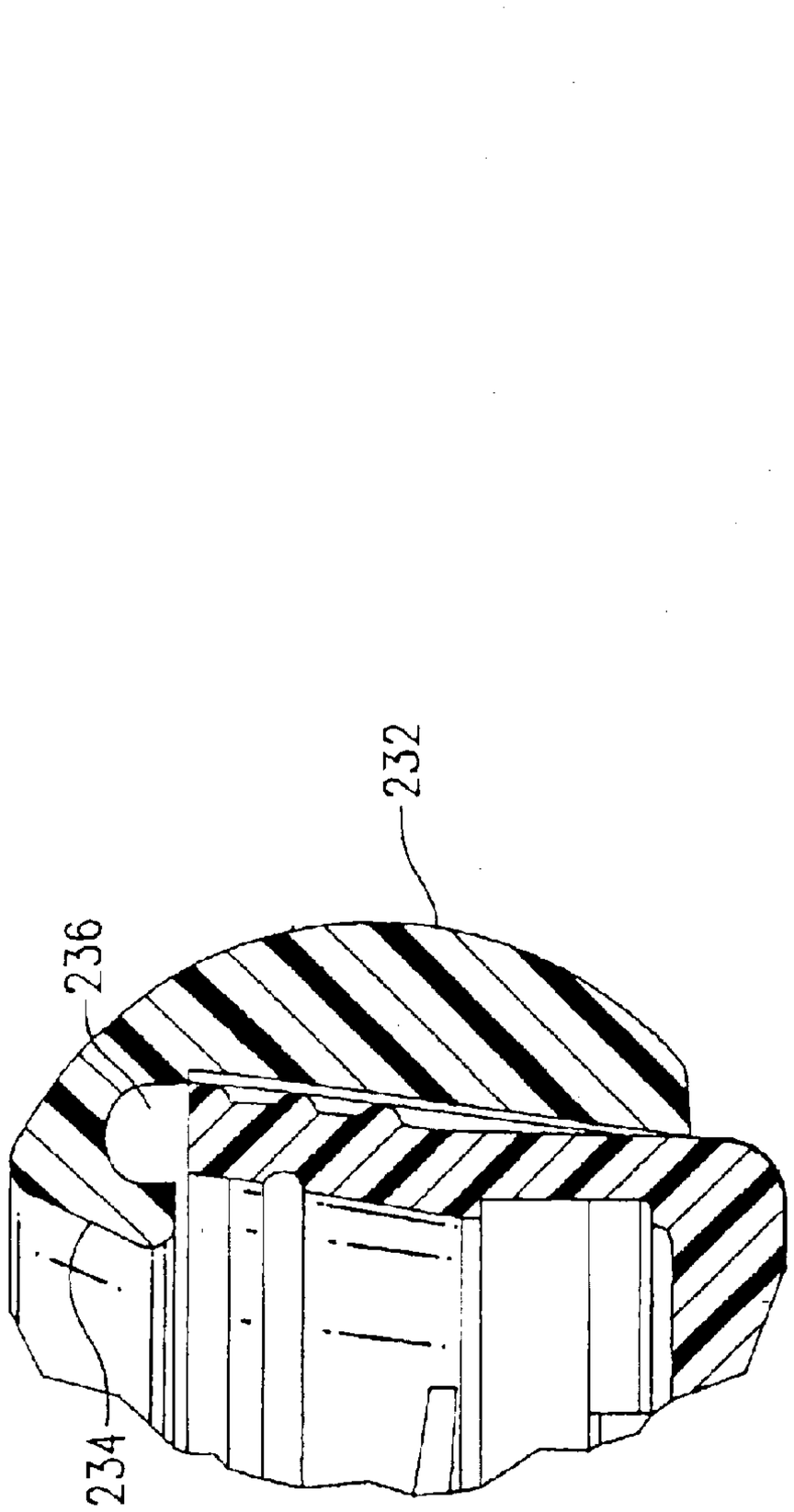

232
236
234

FIG.9A

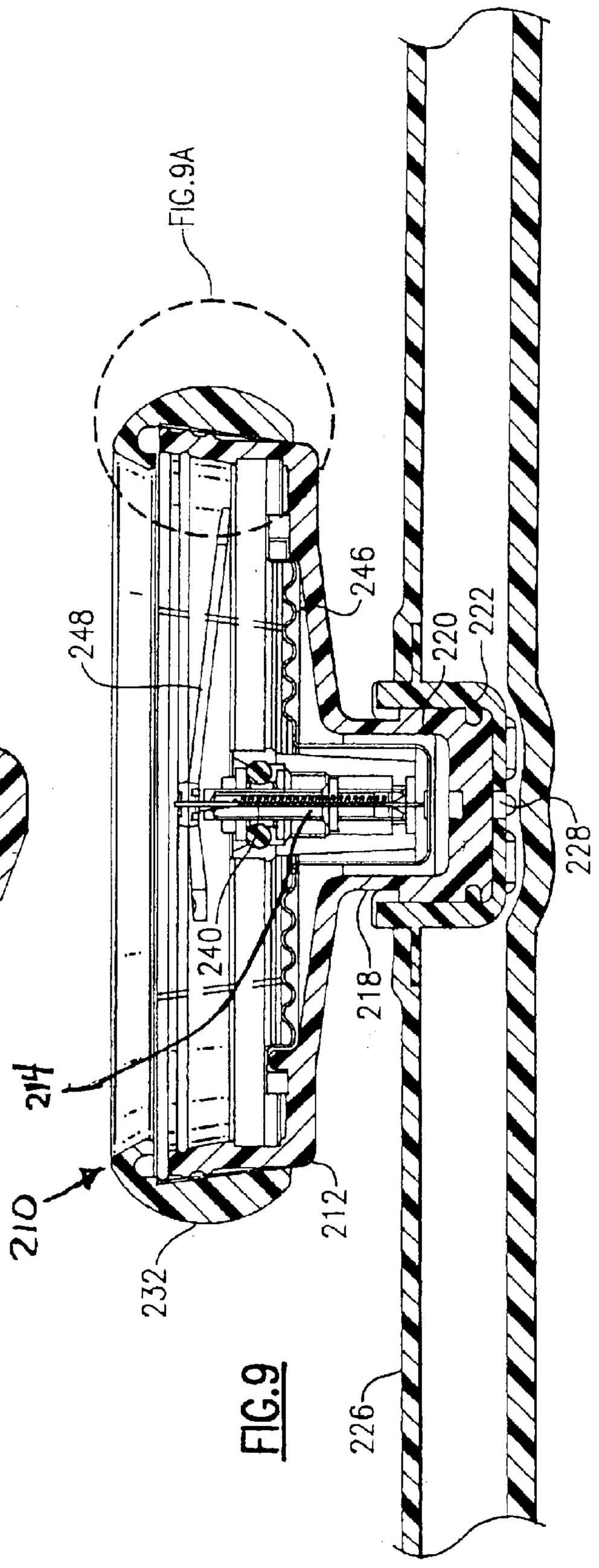


FIG.9A
248
246
220
222
228
240
218
214
210
212
232
226

FIG.9

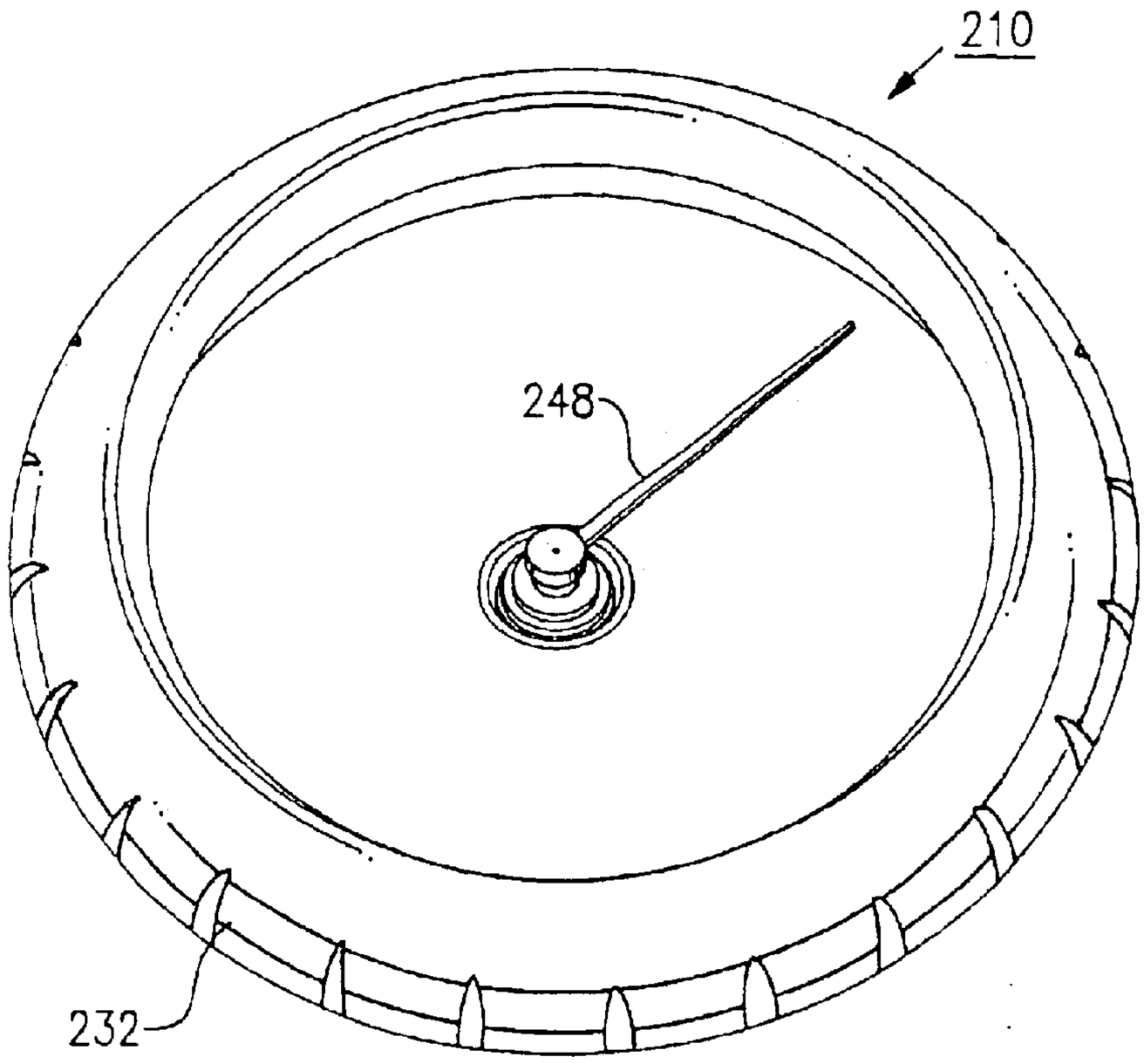



FIG.10

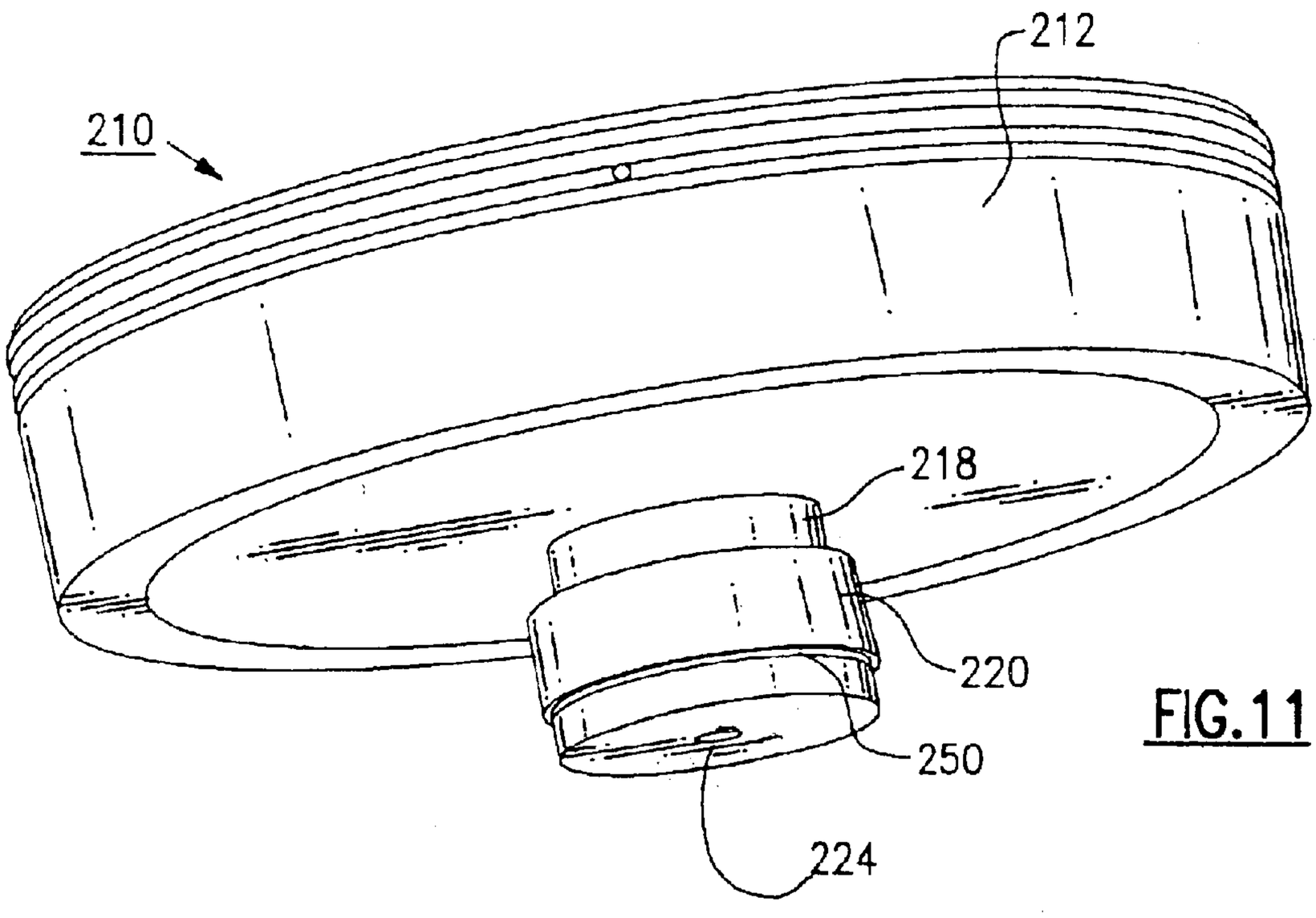



FIG.11

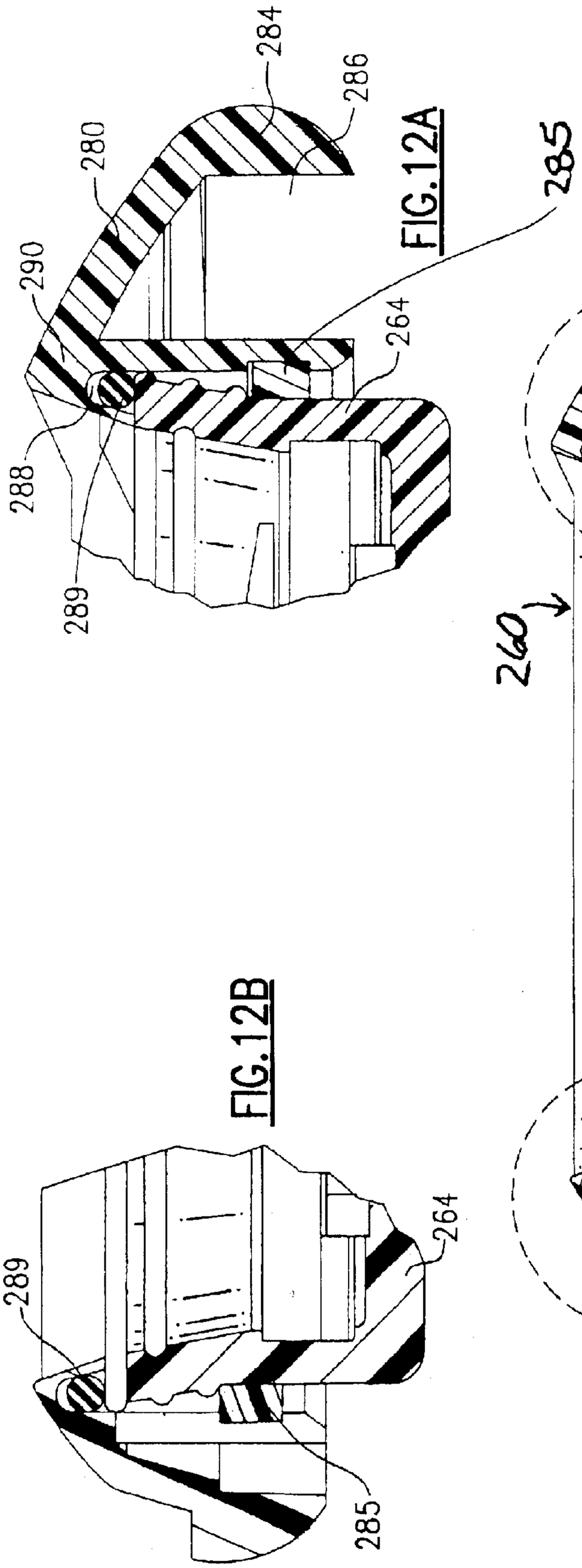

284
286
280
290
288
289
264
285
FIG.12A
FIG.12B
240
268
270
222
226
228

FIG.12

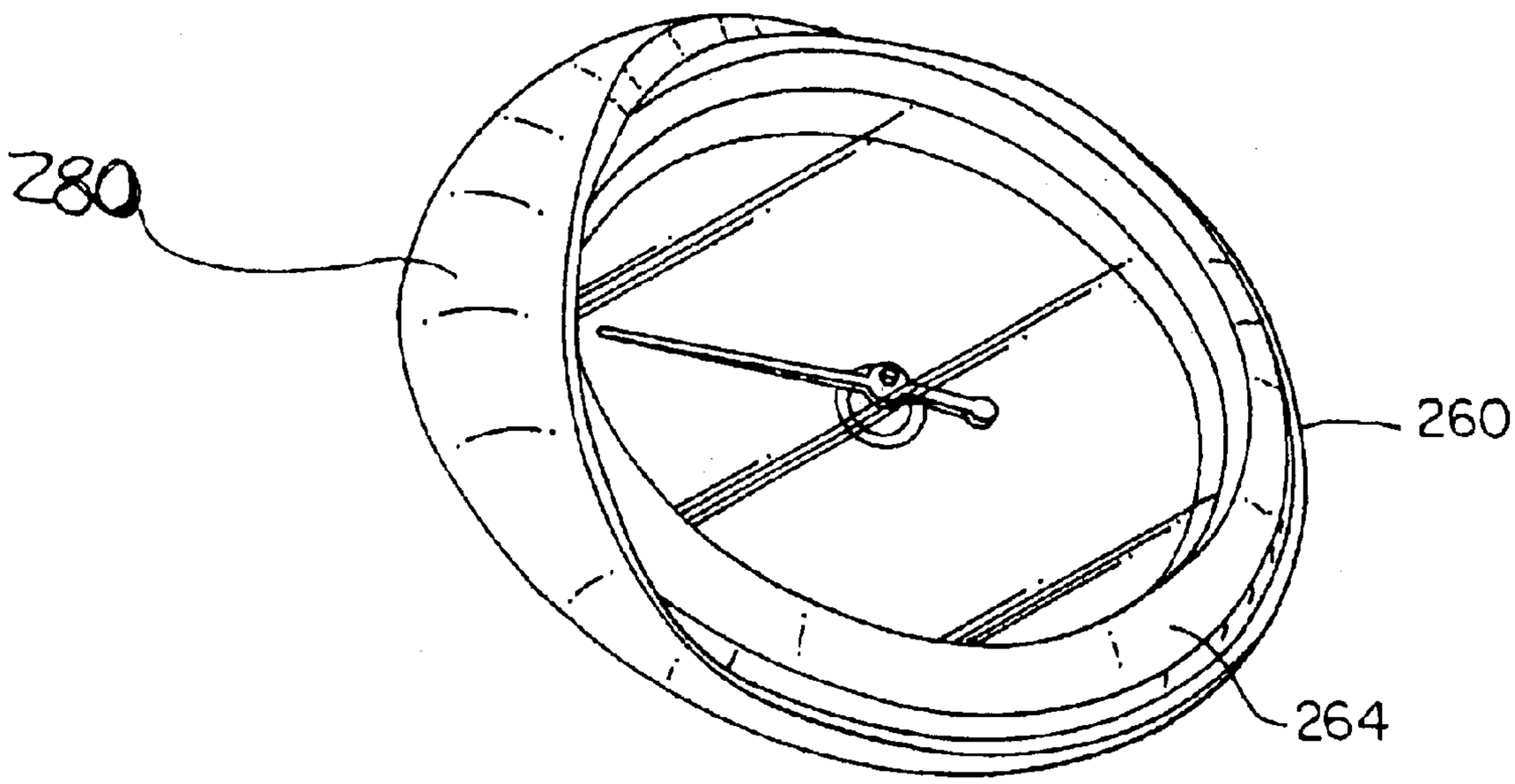



FIG.13

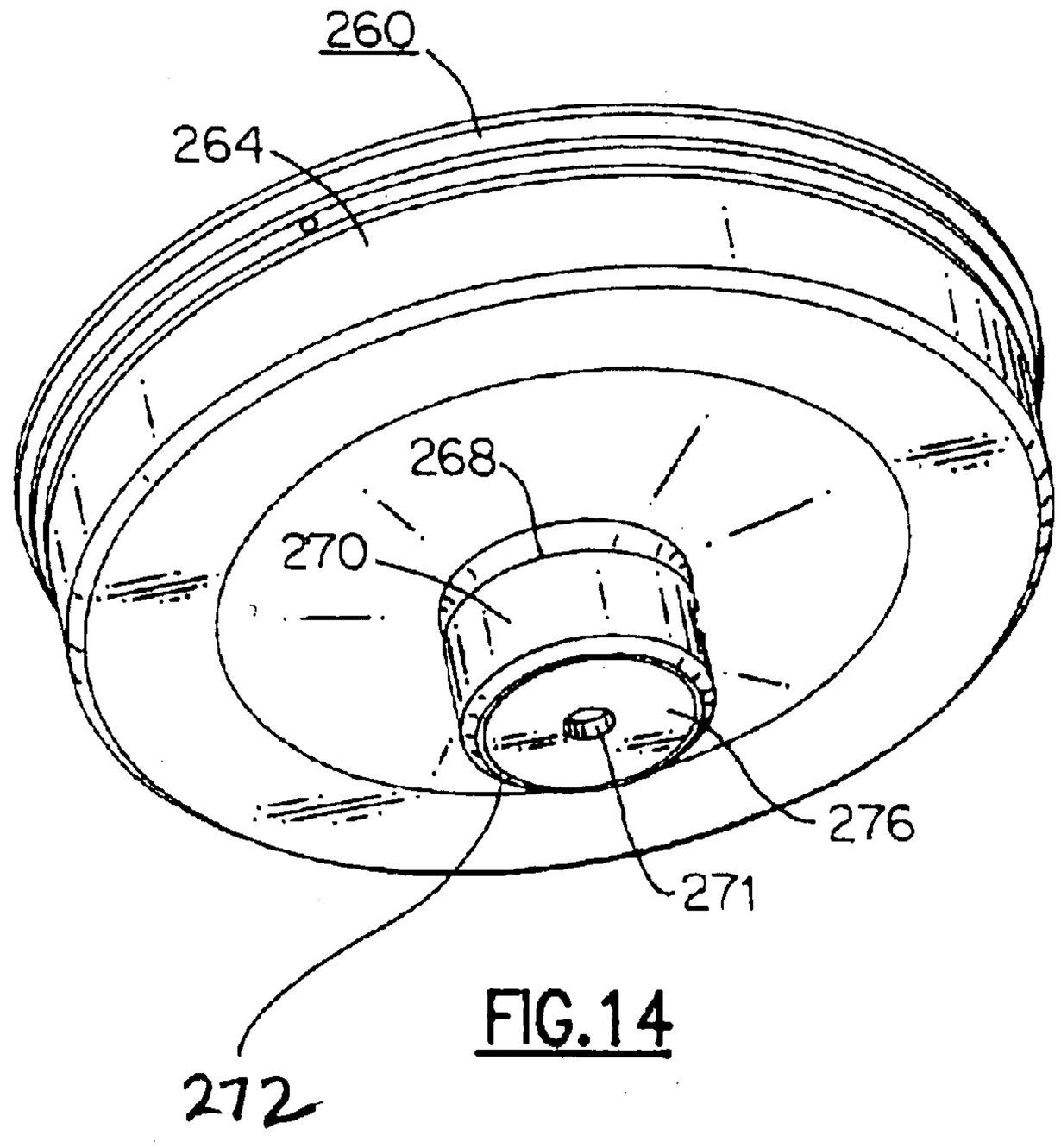
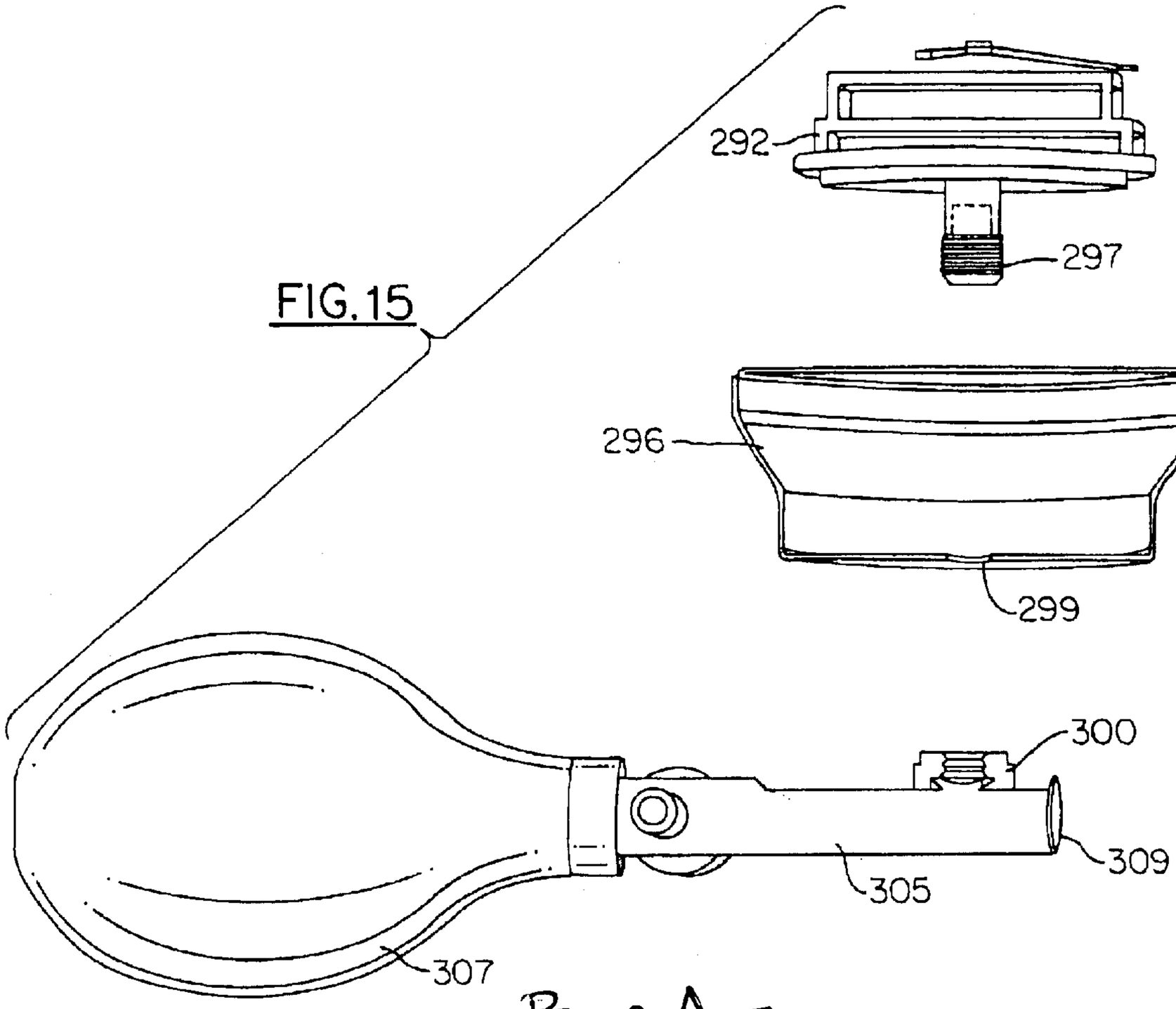



FIG.14

FIG. 15




PRIOR ART

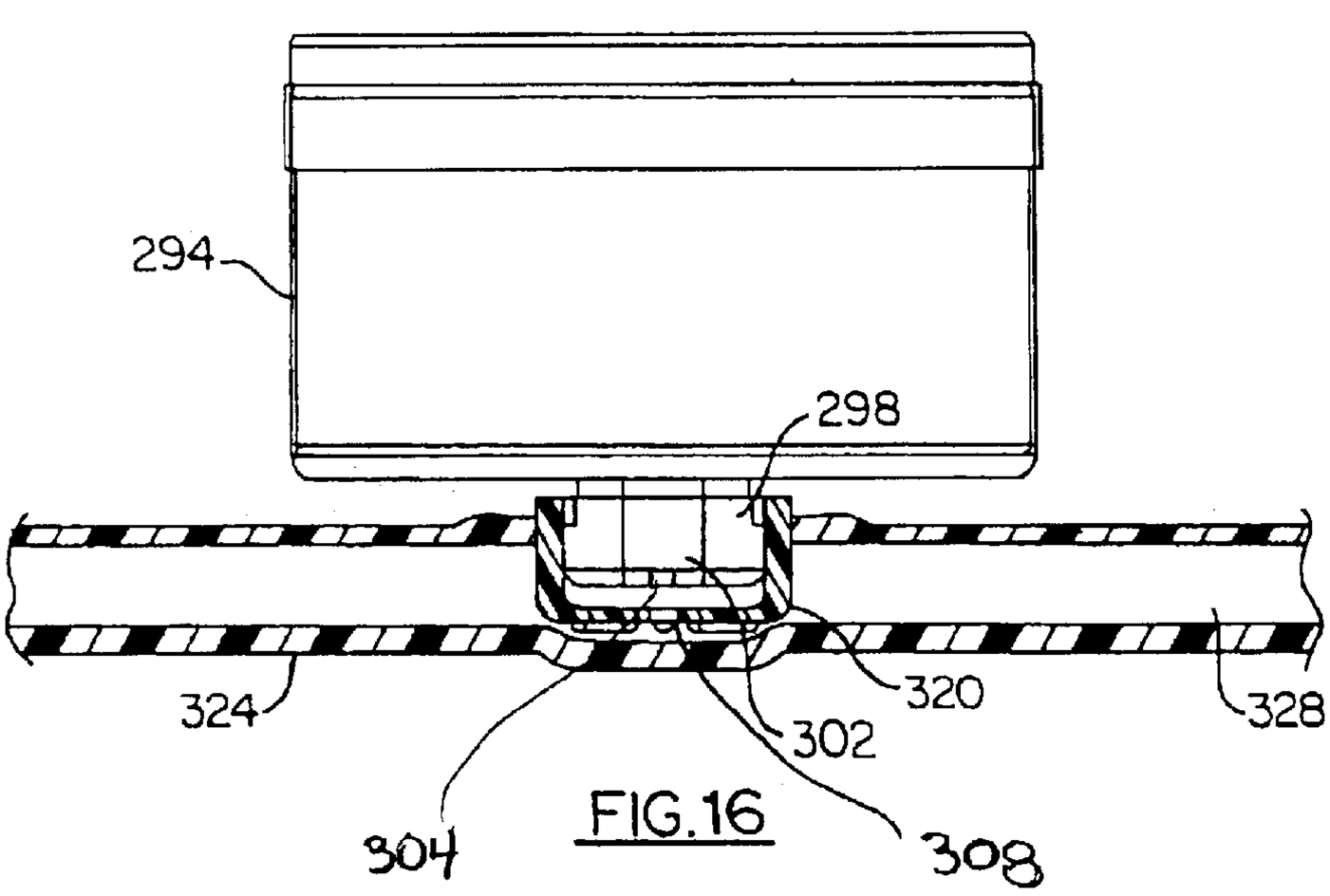



FIG. 16

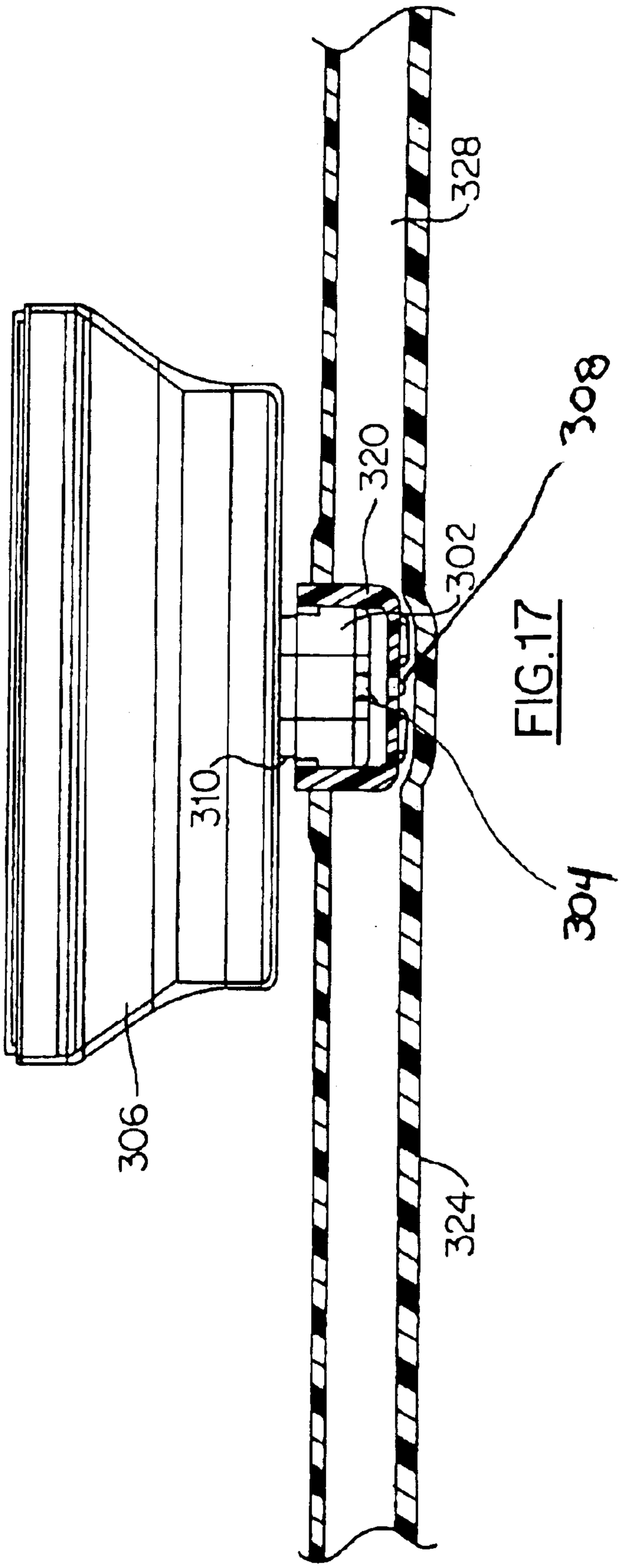



FIG.17

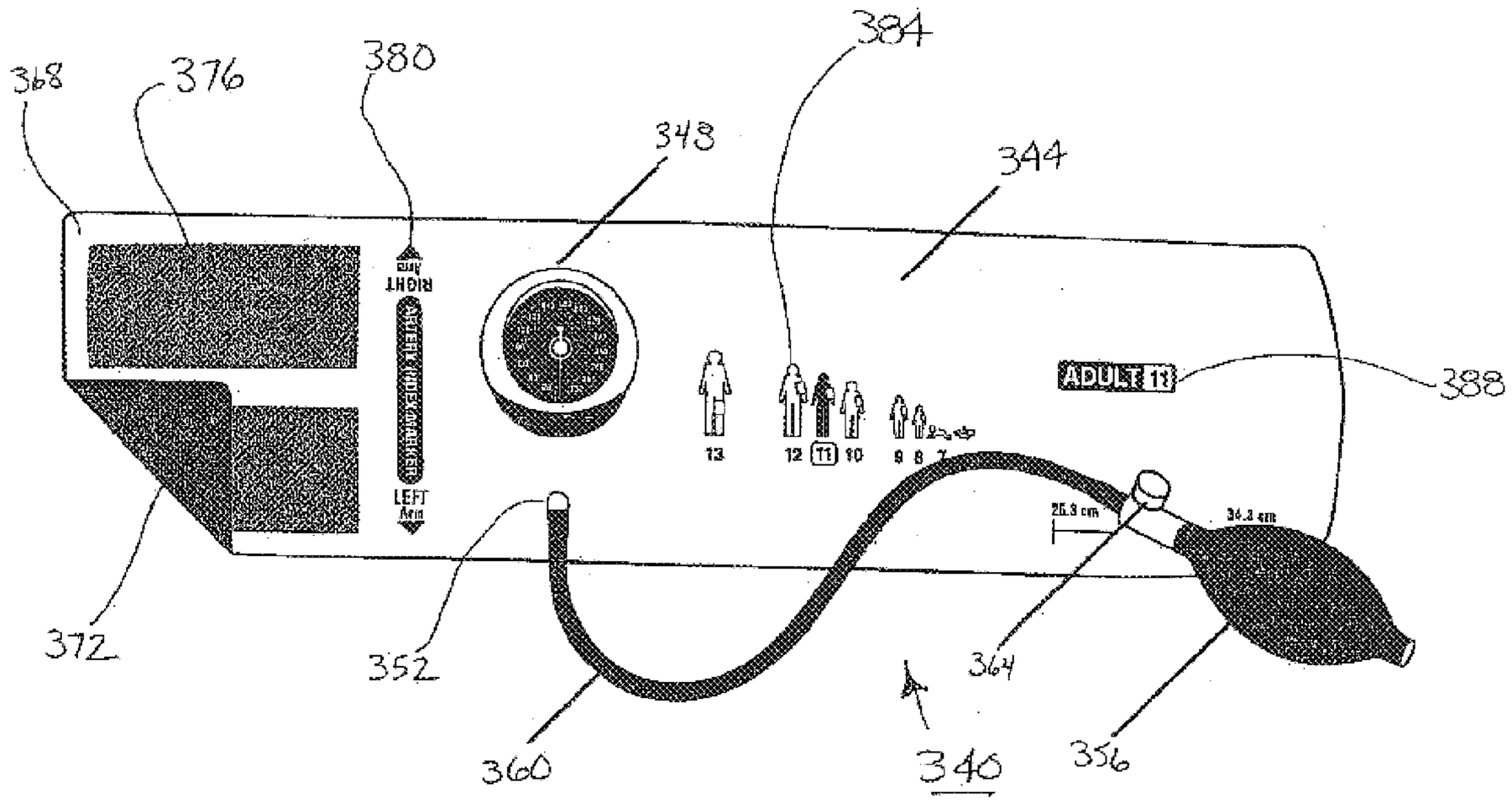

368
376
380
384
348
344
388
372
352
360
340
364
356
RIGHT Arm
LEFT Arm
ADULT 11
13
12
T1
10
9
8
7
26.9 cm
34.3 cm

FIG. 18

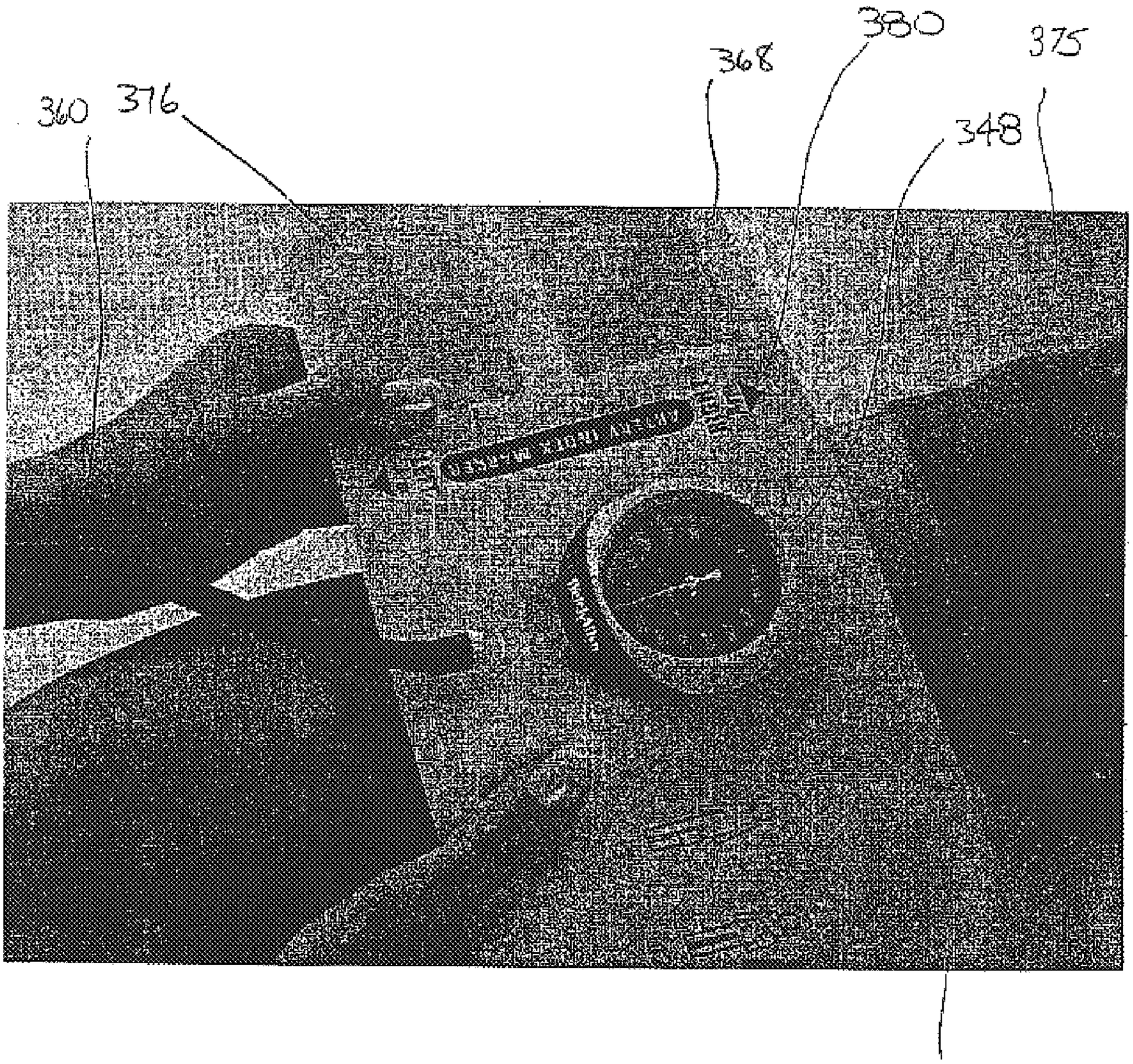



Fig. 19

# BLOOD PRESSURE MEASURING DEVICE WITH DIRECTLY COUPLABLE MEASUREMENT MECHANISM

## CROSS REFERENCE TO RELATED APPLICATION

This application is a divisional (DIV) application of U.S. Ser. No. 09/929,501, filed Aug. 14, 2001, now U.S. Pat. No. 6,615,666 and entitled: PRESSURE MEASURING DEVICE which is a continuation in part (CIP) of U.S. Ser. No. 09/669,474 (U.S. Pat. No. 6,422,086 issued Jul. 23, 2002) filed Sep. 25, 2000.

## FIELD OF THE INVENTION

The invention relates to the field of measuring instruments, and more particularly to a shock-resistant gage housing for a pressure measuring device such as a sphygmomanometer.

## BACKGROUND OF THE INVENTION

Pressure measuring devices such as sphygmomanometers, which are used to measure the arterial blood pressure of a patent, typically include a pneumatic bulb which inflates a pressure chamber of an attached sleeve that is fitted over a limb (i.e., an arm or a leg) of the patient. A diaphragm or bellows assembly, responsive to changes in fluid pressure of the pneumatic bulb and the sleeve pressure chamber, is positioned in a gage housing which is fluidly connected to the pressure chamber of the sleeve through flexible tubes or hoses. A pointer of a dial indicator is interconnected to the bellows assembly through a movement mechanism which is retained within the gage housing, whereby inflation of the bellows causes corresponding circumferential movement of the pointer enabling a blood pressure measurement procedure to be carried out by a caregiver.

Typically, the above referred to movement mechanisms are quite intricate and complex, and are akin in terms of their manufacture and precision to Swiss watches. For example, and in one such movement mechanism, a pair of diaphragm springs are attached adjacent opposing ends of a spindle. A bottom end of the spindle is placed in contact with the bellows assembly and a twisted bronze band perpendicularly disposed at the top end of the spindle is connected in parallel by a horizontally disposed spring bent part. As the spindle deflects axially in response to the inflation of the bellows, the bent spring part is also caused to deflect, thereby causing the band to twist. The pointer, attached to the bronze band, therefore is caused to rotate in relation to an adjacent dial face.

Devices, such as the foregoing, include numerous moving and relatively complex components, some or each of having numerous bearing surfaces. Therefore, such known devices must be manufactured with relatively strict tolerance margins and significant associated costs in terms of both precision and failure rate in order to minimize errors.

In addition, any adjustments required after assembly of the above mechanisms, such as to null the pointer or adjust the sensitivity of the device, require substantial tear down or at least same undesired disassembly.

Furthermore, discrete and separate elements are typically required within the instrument housing for independently supporting the movement mechanism and the bellows assembly, respectively, and for defining an expansion chamber for the bellows assembly there between.



A more recent and simplified movement mechanism is described in U.S. Pat. No. 5,996,829, incorporated by reference in its entirety. The mechanism includes a vertically disposed axial cartridge having a spirally wrapped ribbon spring with one end mounted to an axially movable elongate shaft and the remaining end of the spring being attached to a fixed tubular sleeve. A bottom portion of the elongate shaft is positioned relative to an expandable diaphragm or bellows, wherein subsequent axial translation of the shaft, caused by movement of the diaphragm, elongates the spirally wound ribbon spring and produces repeatable circumferential movement of a pointer supported at the top end of the shaft. The above movement mechanism is far more lightweight than those previously known due to its simplified construction.

A further advance, described in U.S. Pat. No. 6,168,566, also incorporated by reference in its entirety, permits the design of a housing retaining the movement mechanism described in the '829 patent to be far more compact.

In spite of the advancements described herein for making pressure measuring devices lighter and less complex in terms of their manufacture, there is still a corresponding need to improve the overall reliability of such devices, particularly with regard to their ability to withstand impact or shock loading. That is to say, if a gage housing for a blood pressure measuring device were to be dropped during use, it is nearly a certainty that the gage housing would be damaged severely enough to prevent further use of the device.

## SUMMARY OF THE INVENTION

It is a primary object of the present invention to overcome the above-noted deficiencies of the prior art.

It is yet another primary object of the present invention to provide a pressure measuring device which is much more resistant to shock and impact forces than those previously known in the field.

A pressure measuring device, said device comprising:

a housing;

at least one pressure responsive element disposed within said housing;

a movement mechanism having an input end in proximity to a moveable surface of said at least one pressure responsive element;

an indicator connected to an output end of said movement mechanism which indicates changes in pressure; and

shock absorbing means for preventing the transmission of certain shock and impact loads to said device, said shock absorbing means including means for creating a noncontinuous path in order to prevent impinging said shock and input loads from reaching the components contained within the housing.

According to another preferred aspect of the invention, there is provided a pressure measuring device including a housing, said housing retaining a pressure responsive element which is connected to an indicating member that moves relative to a dial face, said device further including a peripheral bumper mounted to said housing, said bumper including an extending portion creating a discontinuous path for a shock or impact load applied to said bumper relative to a movement mechanism retained within said housing.

An advantage of the present invention is that a housing as described herein, such as for use with a blood pressure measuring device, can be dropped or otherwise subjected to shock or impact loads in situations which could be actually encountered during use with minimal damage to the mechanism contained in the housing.

Another advantage of the present invention is that the shock resistant features described herein do not add significant weight to the housing nor detract from the overall reliability or operation of the pressure measuring device.

Yet another advantage of the present invention is that the shock resistant features can easily be manufactured or incorporated into an existing pressure measuring device without significant impacts involving either cost or time.

Still another advantage of the present invention is that other gage housings which can by virtue of an aspect of the present invention be configured for direct connection to a blood pressure sleeve can also include shock resistant features as described herein.

These and other objects, features, and advantages will be more readily apparent to one of ordinary skill in the field from the following Detailed Description which should be read in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view, shown in section, of a pressure measuring device according to the present invention;

FIG. **2** is an enlarged sectional view of the pressure measuring device of FIG. **1**, depicting alternate means for attaching a rotatable dial face in relation to the device;

FIG. **3** is a side elevational view, shown partly in section, of a pressure measuring device having a housing according to a second preferred embodiment;

FIG. **4** is a side elevational view, shown partly in section, of a pressure measuring device having a housing according to a third preferred embodiment;

FIG. **5** is a partial sectional view of a pressure measuring device made in accordance with a fourth preferred embodiment as used with an inflatable blood pressure sleeve;

FIG. **6** is a side elevational view, partly in section, of a pressure measuring device made in accordance with a fifth preferred embodiment of the present invention;

FIG. **7** is an unassembled view of the pressure measuring device of FIG. **6**;

FIG. **8** is a partially exploded view of the housing of the pressure measuring device of FIGS. **6** and **7**;

FIG. **9** is a side elevational view, in section, of a gage housing made in accordance with a sixth embodiment of the present invention;

FIG. **9**A is an enlarged view of the attachment of the peripheral bumper to the gage housing of FIG. **9**;

FIG. **10** is a top perspective view of the gage housing of FIG. **9**;

FIG. **11** is a side perspective view of a gage housing made in accordance with a seventh embodiment of the present invention;

FIG. **12** is a side elevational view, in section, of the gage housing of FIG. **11**;

FIGS. **12**A and **12**B are enlarged partial sectioned views of a protective peripheral bumper as attached to the gage housing of FIG. **12**;

FIG. **13** is a top perspective view of the gage housing of FIG. **12**;

FIG. **14** is a bottom perspective view of the gage housing of FIG. **12** having a shock resistant feature made in accordance with another embodiment of the present invention;

FIG. **15** is a partially exploded view of a conventional blood pressure measuring apparatus;

FIGS. **16** and **17** are side elevation views, partly in section, of conventional gage housings which have been



configured for direct attachment to an inflatable blood pressure sleeve;

FIG. **18** is a top view of a blood pressure measuring apparatus in accordance with a preferred embodiment of the invention; and

FIG. **19** is a perspective view of the inflatable sleeve of the apparatus of FIG. **18** as used with a patient.

## DETAILED DESCRIPTION

The present invention is herein described with reference to several preferred embodiments, each of which specifically relates to blood pressure measuring apparatus. However, it should be evident to one of sufficient skill in the field that certain other variations and modifications could be made utilizing the inventive concepts described herein, as well as alternate applications other than blood pressure measurement, including use in barometers, pressure vessel indicators, pressure sensitive switches, valves, and literally any industrial or medical device requiring a pressure responsive element. Furthermore and throughout the course of the following discussion, terms such as "upwardly", "downwardly", "upper", "lower", "top", "bottom", "vertically", "horizontally" and the like are used to provide a frame of reference with regard to the accompanying drawings. These terms, however, should not be treated as limiting with regard to the invention as described herein. In addition, a number of terms are used herein which require definitions. "Gearless" as used herein refers to any movement mechanism disposed within a gage housing which does not include a gear or gear-like element. The primary embodiments referred to throughout the majority of the following discussion refer to a gearless analog blood pressure measurement apparatus.

"Hoseless" as used herein refers to a direct connection between a gage housing and an inflatable sleeve of a pressure measuring apparatus without any intermediate hose or hoses there between. Several preferred embodiments of hoseless attachments for a blood pressure measuring apparatus are described throughout the course of the following discussion.

Referring to FIG. **1**, there is shown a blood pressure measuring device or apparatus **10** made in accordance with a first embodiment of the invention. The device **10** includes a substantially cylindrical gage housing **12** having an interior cavity **14** defined by a circumferential inner wall **16**, an open top end **18**, and a bottom end **20**. A viewing window or bubble **22**, made from glass, plastic, or other suitable transparent material is attached in a known manner to the open top end **18** of the gage housing **12**. The bottom end **20** of the gage housing **12** has a diameter which inwardly tapers down to a narrow downwardly extending portion **24** having a bottom opening **26** serving as an inlet port for admitting a fluid. Preferably, the diameter of the narrow extending portion **24** is about one third of the diameter of the major portion of the housing **12**, though it will be apparent from the following discussion that this parameter can be suitably varied depending upon the application.

The interior cavity **14** of the housing **12** is sized for retaining a number of component parts, including a horizontally disposed support plate **28**. The support plate **28** is a generally planar member having opposing top and bottom facing sides **30**, **32**, and a central through opening **34**. A press-fitted or otherwise suitably attached or integral sleeve **36** attached to the top facing side **30** of the support plate **28** extends into the central through opening **34** of the support plate **28** and is used for retaining a movement mechanism **40**, described in greater detail below.

The circumferential inner wall **16** of the housing **12** further includes a reflexed portion **19** which is sized for supporting an outer edge **21** of the horizontal support plate **28** immediately there beneath and at a predetermined height within the housing **12**. The central through opening **34** is shown as being substantially aligned with the bottom opening **26** of the housing **12**, but this particular alignment is not critical to the workings of the present invention and therefore can be varied.

Referring to FIGS. **1** and **2**, a diaphragm subassembly **42** includes a flexible diaphragm **44** which is non-fixedly attached to the bottom facing side **32** of the horizontal support plate **28**. The diaphragm **44** is substantially horizontally planar and includes a plurality of wave-like surfaces **49**. An outer edge **47** of the diaphragm **44** is clamped by an O-ring **46** disposed on a circumferential ledge **45** extending upwardly from the bottom end **20** of the housing **12**. The O-ring **46** not only supports the diaphragm **44** in place, but also provides a fluid tight sea for the bottom of the interior cavity **14**.

The centermost portion of the horizontally planar diaphragm **44** includes a downwardly extending section, herein after referred to as the pan **48**, which is soldered or otherwise fixed or even integral with the remainder of the diaphragm **44**. The pan **48** is a hollow cylindrical section which extends into the downwardly extending portion **24** of the housing **12** when assembled and includes a cavity **50** having a width dimension that is substantially equal to that of the press-fitted sleeve **36**. A lower end **53** of the pan **48** includes a interior contact surface **52** which is hardened.

Referring only to FIG. **1**, the movement mechanism **40** includes an axially displace able shaft member **54** which is wholly enclosed within a tubular member **56** with the exception of protruding top and bottom ends **57**, **55**, respectively. A thin flexible ribbon-like spring member **70** is fixedly attached at one end **61** adjacent a bottom end of the tubular member **56** and at an opposite remaining end **59** to the axially displace able shaft member **54** around which the ribbon spring member **70** is helically or spirally wound. The outer tubular member **56** includes a set of external threads **73** extending over an upper portion of the length thereof which engage corresponding internal threads **75** provided in the press-fitted sleeve **36**. The ribbon spring member **70** is preferably fabricated from beryllium copper, spring steel, or other similar material.

The hollow tubular member **56** includes an integral top cap portion **58** having a diameter which is larger than that of the remainder of the member, the cap portion having a shoulder which bears against a biasing spring **68** disposed within an annular recess **69** of the press-fitted sleeve **36**. The top cap portion **58** and the biasing spring **68** are used to adjust the overall sensitivity of the movement mechanism **40**.

When correctly positioned, the majority of the movement mechanism **40** extends beneath the horizontal support plate **28** and into the cavity **50** defined in the pan **48** which is already positioned in the downwardly extending portion **24** of the housing **12**. In this position, the extending bottom end **55** of the shaft member **54** is proximate to the hardened contact surface **52**.

Still referring to FIG. **1**, a dial face **63** having measuring indicia (not shown) is attached to the top facing side **30** of the horizontal support plate **28** through a center opening which is sized to fit over the press-fitted sleeve **36**. An O-ring **65** disposed in a slot **67** of the tubular sleeve **36** engages an inner edge of the dial face **63** with an indicating member **62** being mounted to the protruding top end **57** of the shaft member **54**. A preferred lightweight indicating member useful in his design is described in U.S. Ser. No. 09/471,847, the entire contents of which are herein incorporated by reference.

In operation, changes in the pressure of incoming fluid (in this example, air) entering the bottom opening **26** of the housing **12** cause corresponding movements of the diaphragm **44**. That is, the seal provided onto the outer edge **47** of the diaphragm **44** by the O-ring **46** clamping against the bottom facing side **32** of the horizontal support plate **28** prevents air from further penetrating into the interior cavity **14**. Therefore, the increase in pressure causes axial movement of the diaphragm pan **48** with the interior contact surface **52** being caused to push upwardly against the bottom end **55** of the axially displace able shaft member **54**. As a result of the upward movement of the diaphragm **44**, the ribbon spring member **70** is caused to extend against the fixed end **61** of the tubular member **56**, causing the shaft member **54** to rotate about its linear axis. The rotation of the axially displace able shaft member **54** therefore causes a corresponding circumferential movement of the indicating member **62** attached to the top end **57** of the shaft member **54** relative to the measuring indicia (not shown) on the dial face **63**.

Zero adjustment of the above pressure measuring device **10** is a relatively simple procedure, as compared with previously known devices. First, the viewing window **22** is removed from the open top end **18** of the gage housing **12**. The engagement of the O-ring **65** against the inner edge of the dial face **63** allows the dial face to be freely rotated in relation to the position of the indicating member **62**. Sensitivity adjustments can also be made at the top of the device **10** by rotating the top cap portion **58** against the biasing spring **68** within the annular recess **69** of the press-fitted sleeve **36**, so as to adjust the sensitivity of the ribbon spring member **70** for a given rotation. A similar mechanism is described in previously incorporated U.S. Pat. No. 6,168,566.

Variations of the above device are possible. For example and referring to FIG. **2** and in lieu of an O-ring, either the dial face **63**A and/or the horizontal support plate **28**A can be tapered suitably adjacent their center openings relative to a slot **80** provided in the tubular sleeve **36**A in order to allow the dial face to be rotated without requiring removal. Alternately, the movement mechanism **40** can include a zero adjustment feature as described in U.S. Pat. No. 5,966,829 and U.S. Pat. No. 6,168,566. In passing, it should be noted that FIG. **2** merely illustrates a portion of the overall assembly in order to distinctly facilitate the above discussion.

A housing design in accordance with a second embodiment is illustrated in FIG. **3**. Similar parts are herein labeled with the same reference numerals for the sake of clarity. As in the preceding, the device includes a gage housing **12** having an interior cavity **14** sized for retaining a diaphragm assembly **42** which includes a diaphragm **44** having a series of wave-like surfaces **49** as well as a downwardly extending portion or pan **48**. The device further includes a substantially horizontally disposed planar support plate **28**, the housing **12** further having a downwardly extending narrowed portion **24**. A movement mechanism **40** is disposed through a central opening **34** defined in the horizontal support plate **28** such that the bottom end **55** of an axially displace able shaft **54** of the mechanism is disposed in proximity to a hardened contact surface **52** of the pan **48** of the diaphragm assembly **42**. The diaphragm **44** in the meantime is attached, but sealed, to the bottom facing side **32** of the horizontal support plate **28**.

Fluid, such as air, entering the gage housing **12** through a bottom opening **26** causes deflection of the pan **48** of the diaphragm **44** against the axially displace able shaft **54**, thereby causing rotation of the shaft by means of an attached ribbon spring member **70**, according to the manner previously described.

According to this particular embodiment, the device includes a docking hub **82** provided on the exterior of narrow downwardly extending portion **24** of the housing **12**, the hub including a circumferential slot **114** which is sized for retaining an O-ring **118** or other similar sealing element. For example, the docking hub **82** can utilize pipe or other form of known threads (not shown). The docking hub **82** provides adequate modification to allow the device to be attached to other existing pressure device housings having pressure sources, for example, those manufactured by Welch Allyn, Inc. of Skaneateles Falls, N.Y., among others. In passing, it should be noted that the position of the bottom opening **26** of the housing **12** is not essential; that is, incoming fluid can enter the housing **12** from either a horizontally or otherwise disposed port, so long as the opening is beneath the seal which is provided by the O-ring **118**.

To further illustrate variations and referring to FIG. **4**, a third embodiment of a housing **12**B made in accordance with the present invention includes a diaphragm **44**B, which unlike the preceding embodiments, is a substantially vertical member having an overall width dimension that is considerably narrower than those previously described. As a result, a horizontal support plate is not required as in the preceding which is fitted to the circumferential inner wall **16** of the housing **12**B.

Like the preceding embodiments, an outer edge **47**B of the diaphragm **44**B is sealed using an O-ring **46**B or other sealing member which effectively clamps the outer edge to a shoulder of the a press-fitted sleeve **36**B. The movement mechanism **40** is disposed essentially through a center opening in a press-fitted sleeve **36**B and threaded into engagement therewith. The majority of the movement mechanism **40** is disposed within the cavity defined by the essentially vertical diaphragm **44**B, the particular diaphragm of this embodiment having vertically disposed wave-like surfaces **49**B. Adjustments to control the sensitivity of the movement mechanism **40** using biasing spring **68**B are performed in the manner previously described.

Overall, the housing of the instant embodiment defines a very shallow profile for the upper portion of the gage housing **12**B. Though not shown, the bottom end **20**B of the gage housing **12**B can be used as a docking hub to secure the gage housing into other gage housings (not shown) either as a retrofitted or as a new assembly as previously described. As further described herein, this docking hub can also permit direct hose-free connection between a gage housing and an inflatable blood pressure sleeve.

Referring to FIG. **5**, a gage or instrument housing **140** formed in accordance with a fourth embodiment of the present invention is herein described in combination with a blood pressure sleeve or cuff **142**. For purposes of the present embodiment, the instrument housing **140** is used with a specific blood pressure cuff which is described in greater detail in U.S. Pat. No. 6,036,718, the contents of which are hereby incorporated in its entirety. In brief, the inflatable cuff **142** is manufactured using a pair of sleeve portions **144**, **146** which are sealed together using a series of continuous RF (radio frequency) welds to form an integral bladder less structure having an inflatable inner volume **148**. In operation, the cuff **142** is then wrapped as conventionally known about the arm **170** (partially shown) or other limb of a patient.

The gage housing **140** includes an upper housing portion **152**, a lower housing portion **154**, and a connecting intermediate portion **156**. The upper and lower housing portions **152**, **154** are substantially cylindrical in cross section and have approximately the same dimensions while the intermediate portion **156** has a substantially smaller diameter that is considerably narrower than either adjoining section, thereby defining a configuration resembling a yo-yo. According to the present embodiment, the intermediate portion **156** has a diameter which is approximately one third the diameter of the remaining portions **152**, **154**, but it will be readily apparent that this parameter can be varied depending on the relative size of the movement mechanism used therein. Each of the above portions **152**, **154**, **156** are interconnected and hollow, combining to form an interior cavity **158**.

According to this embodiment, a horizontal support plate **165** (shown in phantom) is positioned within the lower portion **154** of the housing **140** while a dial face **167** (also shown in phantom) is disposed in the upper portion **152**. A movement mechanism **171** (also shown in phantom) which is similar structurally to those previously described, interconnects the dial face **167** and the support plate **165** and is located primarily in the intermediate portion **156**.

According to this embodiment, a slot **162** is cut into one of the sleeve portions **144**, **146**. The slot **162** provides a button-like retainment for the lower portion **154** of the housing **140** as well as the intermediate portion **156**, with the upper portion **152** protruding from the exterior of the cuff **142**. A port **176** is connected via a hose **178** to the inflatable inner volume **148** of the cuff **142** which is inflated by a pneumatic bulb (not shown) in a well known manner.

In operation, the device operates similarly to that previously described, except that a detachable stethoscope adapter **166** can also be attached to the bottom of the lower housing portion **154**, thereby forming an integral unit. The bottom of the lower portion **154**, according to this embodiment, includes an extending attachment portion **174** sized to engage a female connector **180** or other suitable means provided on the adapter **166**. All preceding known cuffs require separation between the cuff and the stethoscope. With the overall shallow profile of the above housing **140**, use of an adapter **166** permits an interconnection which is highly advantageous.

The stethoscope adapter **166** is a conical member which forms the bell of the stethoscope having connecting ear pieces (not shown) attached to a port **184**. In use, the adapter **166** is freely rotatable relative to the housing **140**, allowing examination by a patient or care giver to be performed equally well. The overall workings of stethoscopes are commonly known and do not form part of the inventive concepts described hereon.

Referring to FIGS. **6–8**, there is shown a blood pressure measuring device made in accordance with a fifth embodiment of the present invention. As in the preceding, similar parts are labeled with the same reference numerals for the sake of clarity. This device includes an RF welded blood pressure sleeve **142** similar to that described in the previously incorporated '718 patent including a pair of sleeve portions **144**, **146** which are sealed together to form an integral structure and define an inflatable inner volume **148**. The sleeve **142** is sized to be wrapped around the arm or other limb of a patient (not shown) in a manner which is

commonly known, and therefore requiring no further explanation. A socket **190** is disposed and fixed within a slot which is provided on the exterior of one of the sleeve portions **144**, the socket being sized to receive a mating portion of an instrument or gage housing **194**. The instrument housing **194** according to this embodiment is similar to those previously described including a narrowed bottom portion, but in which the bottom portion also includes a ball-shaped engagement or mating end **196**. When assembled, the ball-shaped engagement end **196** is fitted within the socket **190** of the sleeve in order to provide a direct fluid and sealed connection therewith, the gage housing **194** being free to pivot about the plane of the sleeve **142** as shown by reference numeral **198**.

The engagement end **196** includes an opening **200** which permits fluid communication with the interior of the sleeve **142** wherein fluid (air) can enter the interior of the gage housing **194** to cause corresponding movement of a diaphragm and a contained movement mechanism (not shown), in the manner previously described herein.

Preferably, the viewing window **22** of the housing **194** includes an anti-reflective coating to reduce or substantially reduce glare, with the user (physician or care giver) or patient having the ability to either rotate the housing or to pivot same in order to effectively utilize the instrument and read the dial face. As such, the gage housing **194** can effectively be used in either a right or left armed patient measurement. A sleeve which further provides this ability with an attached gage housing is described in greater detail below.

Still referring to FIGS. **6–8**, the device further includes a rubberized ring-shaped guard or bumper **202** which is press-fitted into engagement about the outer periphery of the gage housing **194**, the bumper having a ridge **206** which extends a predetermined distance above the viewing window **22**. The bumper **202** performs at least two functions; first, and though the present device is ultra lightweight, the bumper additionally absorbs shock or impact loads when the housing **194** is dropped. Second, the bumper **202** also prevents damage to the viewing window **22**.

As described in greater detail in a succeeding embodiment, it should be noted herein that the mating or engagement end of the narrowed bottom portion of the instrument or gage housing need not include a ball-shape for accommodation within the sleeve socket **190**. Examples are discussed below with reference to FIGS. **9–14**.

Furthermore, it should also be apparent that other conventionally known gage housings which include a pressure responsive member can be configured or retrofitted for direct engagement with a blood pressure sleeve without requiring hoses (hoseless) between the housing and the sleeve. An example is partially shown in FIG. **15**, a gage housing **296** retaining a conventional movement mechanism **292**. The movement mechanism **292** includes a threaded end **297** which extends through a bottom opening **299** of the housing **296** and is received into the mating threaded end of a port **300** of a tubular member **305**, the input end of which includes a pneumatic bulb **307**. In use, the output end **309** of the tubular member **305** receives a hose (not shown) which extends to a coupling of a blood pressure sleeve (not shown).

Referring to FIGS. **16** and **17**, respectively, a pair of known gage housings **294**, **306** are shown which can be interconnected to a blood pressure sleeve **324** in a manner similar that previously described. Each of these conventional housings **294**, **306**, similar to those of FIG. **15**, are less compact than those which have been expressly detailed, mainly because of the intricacy and sizing of the movement mechanism that is contained therein. Each of the gage housings **294**, **306**, however, do commonly contain a threaded engagement end or inlet port **298**, **310**, which permits fluid communication between the housing interior and the pneumatic bulb **307**, FIG. **15**. The bulb **307** is attached using a hose (not shown) to the inlet port. Literally any gage housing having an engagement or inlet end and including literally any form of movement mechanism can be reconfigured according to the present invention for hoseless interconnection with an inflatable sleeve.

According to the present invention and in order to retrofit the gage housings **294**, **306**, the end of the threaded inlet port **298**, **310** can be covered with an adapter or cap **302** which is sized for sealing engagement within a socket **320** provided in an inflatable blood pressure sleeve **324**. The cap **302** and the socket **320** each include respective openings **304**, **308**, which as shown in FIGS. **16** and **17** upon attachment to the inflatable sleeve **324**, permits direct fluid communication between the interior **328** of the sleeve **324** and the interior of the housing **294**, **306**, the housing being preferably snap-fitted to the sleeve. As a result, there is no need to include the tubes which are essential to the prior art assembly of FIG. **15**, thereby greatly simplifying the use of even conventional devices by permitting direct, hose free connection to an inflatable blood pressure sleeve.

In passing, it should further be noted that though an RF welded or bonded inflatable sleeve is described throughout, other forms of inflatable sleeves can be utilized embodying the central concepts of the present invention, including both bladderless sleeves and sleeves having bladders. Furthermore, and though the above concept relies upon a releasable snap-fit coupling between a socket and mating engagement end of a gage housing, there are other coupling schemes such as interference fits, fitted slots and the like, as well as integral fits between a sleeve and gage housing which are intended to be covered as part of the inventive aspects of the present invention.

Referring to FIGS. **9–11**, there is shown a gage or instrument housing **210** according to a sixth embodiment of the present invention. As in the preceding, the gage housing **210** is used in connection with a blood pressure measuring device and includes an upper housing portion **212** which retains a movement mechanism **214** and a narrowed lower portion **218** having a mating or engagement end **220** which is sized to engage a generally cylindrical socket **222** formed in a sleeve portion of a bladderless blood pressure cuff or sleeve **226**. Unlike the preceding embodiment, the mating end **220** of the narrowed lower portion **218** is also generally cylindrical in cross section, the end similarly including an end opening **224**, shown in FIG. **11**, which permits fluid communication with the interior of the blood pressure cuff **226** via a corresponding opening **228** also formed in the socket **222**, thereby forming a fluid inlet port.

The upper housing portion **212** of the gage housing **210** and the contained movement mechanism **214** are similar to those previously described. That is, the movement mechanism **214** includes a helically wound thin ribbon spring **240** which is attached at one end to an axially displaceable shaft member and at a second end to a tubular sleeve member in the manner described above. Changes in pressure of the cuff **226** cause fluid to enter the narrowed lower housing portion **218** through the end opening **224**, affecting a contained diaphragm **246** and causing the axially displaceable shaft member to be translated upwardly, resulting in rotation of the shaft member against the biasing of the ribbon spring **240** and circumferential movement of an indicating member

248, attached to a protruding top end of the shaft member, relative to a dial face.

The mating end **220** of the narrowed lower housing portion **218** further includes a circumferential channel or notch **250**, which is most clearly shown in FIG. **11**. The circumferential channel **250** provides a discontinuous path for shock and impact loads and, therefore, effectively cushions the contents of the gage housing **210** including the movement mechanism **214**, from shock or impact loads such as when the housing **210** lands on the narrowed lower portion **218**.

According to this embodiment and as most clearly shown in FIGS. **9** and **10**, and to further insulate the housing **210** from damage due to shock or impact loading, a rubberized peripheral guard or bumper member **232**, sized to fit over the exterior periphery of the upper housing portion **212** is press fitted into engagement therewith. The guard member **232** is similar to that previously described above in that the entire periphery of the upper housing portion **212** is covered, the guard member including a stepped portion **234**, shown in FIG. **9**A, which extends over the top of the upper housing portion, including the viewing window, and defines an air gap **236** along the outer circumferential edge thereof. The air gap **236** provides a discontinuous path for any impact loads which can occur if the gage housing **210** lands awkwardly.

Variations of the above embodiment of FIGS. **9–11** are possible. For example, and referring to FIGS. **12–14**, there is shown a gage housing **260** according to a seventh embodiment of the present invention. The gage housing **260** also includes an upper housing portion **264** and a narrowed lower housing portion **268** having an engagement end **270** which mates with a socket **222** which is formed in blood pressure sleeve **226**. The upper housing portion **264** according to this embodiment is defined by a substantially elliptical cylindrical cross section as opposed to the preceding embodiments in which the upper housing portions are substantially circular cylinders. It should be noted that other shapes or geometries could be contemplated. According to this embodiment, a circumferential channel **272** provided in the bottom surface **276** of the engagement end **270** provides a similar function to the axial circumferential channel **250**, FIG. **11**, with regard to shock or impact loads applied to the housing if dropped or otherwise acted upon.

Otherwise, the engagement end **270** similarly engages the socket **222** of the sleeve **226**, the gage housing **260** retaining a movement mechanism (not shown) as previously described. The engagement end **270** includes an end opening **271** which permits hoseless fluid communication with the sleeve **226**, also as previously described, through a socket opening **228** which extends to the sleeve interior.

According to the instant embodiment, a rubberized guard member **280** is press fitted over the exterior periphery of the upper housing portion **264**, the guard member according to this embodiment including a radially extending portion **284** which when attached extends from the outer edge of the elliptically shaped upper housing portion **264** and similarly provides a cushioning air gap **286** which creates a discontinuity, in fact a buffer, which insulates the housing **260** from impact loads when the housing is dropped. Similar air gaps **288** are provided above the viewing window as defined in an axially extending portion **290** to provide additional protection against shock or impact loads.

As shown in FIG. **12**A, an O-ring **289** is provided within the annular air gap **288**. Additional shock resistance between adjoining portions of the housing **264** and the interior wall surface of the guard member include an annular rubberized shim **285**.

Referring to FIGS. **18** and **19**, a sleeve **344** for a blood pressure measuring apparatus **340** is herein described.

The sleeve **344** itself is constructed from a pair of sleeve portions **368, 372** made from a polyamide or other similar fluid impermeable material which are RF welded or bonded together and define an interior chamber. The interior chamber of the sleeve **344** is inflated by means of a pneumatic bulb **356** which is tethered by tubing **360** to a barb or port **352** provided on a sleeve portion **368**, the barb having an opening which is in communication with the interior chamber of the sleeve. A check valve **364** provided adjacent to the pneumatic bulb **356** permits depression thereof when the valve is opened.

The sleeve **344** includes hook and loop fastener portions (only one of which **376** being shown) on the outward facing sides of each of the sleeve portions **368, 372** at opposite ends of the sleeve, thereby permitting the sleeve to be formed into a cylindrical shape and secured when wrapped about the limb of a patient **375**, as shown in FIG. **19**. Each hook and loop fastener portion **376** is also preferably RF welded to a sleeve portion **368, 372**. Specific features relating to the above noted features, including the manufacture of the herein described sleeve **344**, are described in U.S. Pat. No. 6,036,718, herein previously incorporated by reference in its entirety.

When properly attached, the facing side of the sleeve portion **372** contacts the patient with the facing side of the sleeve portion **368** being exposed. According to the present embodiment, each facing side has a different color to assist in attaching same to the patient. According to the present embodiment, the sleeve **344** is two-toned with the facing side of the sleeve portion **372** having a black colored finish and the facing side of the exposed sleeve portion **368** having a lighter colored finish.

A socket or port (not shown) similar to those described above and shown for example in FIGS. **9** and **12** is also provided in the sleeve portion **368**, the socket being sized for receiving a gage housing **348** which is releasably snap-fitted in the manner previously described and defined. The gage housing **348**, when attached, can be rotated about its vertical axis, permitting easy visual access to either the care giver and/or the patient.

The gage housing **348** according to this embodiment is identical to that previously shown and described in FIG. **9**, the housing containing a bellows assembly as well as a gearless movement mechanism which operates in the manner described above to permit circumferential movement of an indicating member relative to a dial face when pressure changes within the interior chamber of the sleeve **344** cause movement to a movable surface of the bellows assembly. The gage housing **348** also preferably includes the shock/impact resistant features previously described.

An artery index marker **380** is provided adjacent the hook and loop fastener portion **376** on the facing side of the sleeve portion **368**. This marker **380** is used to align the sleeve with the brachial artery of the patient, the marker further including left and right limb indicators which are provided on respective lateral sides of the sleeve **344**. When the sleeve **344** is wrapped over the arm of the patient **375**, the marker is used to properly and circumferentially align the arm and the artery with the limb indicator pointing directly at the artery. The rotatability of the gage housing **348** within the sleeve **344** permits the sleeve having the attached gage housing to be used when attached regardless of orientation.

According to the present invention, sets of indicia **384, 388** are also provided on the facing side of the sleeve portion

**368** designating the size of sleeve being used; that is, whether the sleeve is an adult, child or neonatal cuff. An adult sleeve is shown in the present embodiment. The gage housing **348** can be releasably attached in the manner described herein to any of the above noted sleeves, regardless of size.

Parts List for FIGS. **1–19**

**10** blood pressure measuring device or apparatus
**12** gage housing
**12**B gage housing
**14** interior cavity
**16** circumferential inner wall
**18** open top end
**19** reflexed portion
**20** bottom end
**20**B bottom end
**21** outer edge (support plate)
**22** bubble or viewing window
**24** downwardly extending portion
**26** bottom opening
**28** horizontal support plate
**28**A horizontal support plate
**30** top facing side
**32** bottom facing side
**34** central through opening
**36** sleeve
**36**A sleeve
**36**B sleeve
**40** movement mechanism
**42** diaphragm subassembly
**44** diaphragm
**44**B diaphragm
**45** circumferential ridge
**46** O-ring
**46**B O-ring
**47** outer edge
**47**B outer edge
**48** pan
**49** wave-like surfaces
**49**B wave-like surfaces
**50** cavity
**51** cavity
**52** contact surface
**53** lower end
**54** axially displaceable shaft member
**55** bottom end
**56** tubular member
**57** top end
**58** top cap portion
**59** end-ribbon spring
**61** end-ribbon spring
**62** indicating member
**63** dial face
**63**A dial face
**65** O-ring
**66** threads
**67** slot
**68** biasing spring
**68**B biasing spring
**69** recess
**70** ribbon spring member
**72** one end
**73** threads
**75** threads
**80** slot
**82** docking hub
**114** circumferential slot
**118** O-ring
**140** gage or instrument housing
**142** cuff
**144** sleeve portion
**146** sleeve portion
**148** inner volume
**152** upper housing portion
**154** lower housing portion
**156** intermediate portion
**158** interior cavity
**162** slot
**165** support plate
**166** detachable stethoscope adapter
**167** dial face
**170** arm
**171** movement mechanism
**174** extending attachment portion
**176** port
**178** hose
**180** female connector
**184** port
**190** socket
**194** instrument or gage housing
**196** ball-shaped engagement end
**198** direction
**200** opening
**202** peripheral bumper
**206** ridge
**210** gage housing
**212** upper housing portion
**214** movement mechanism
**218** narrowed lower housing portion
**220** engagement or mating end
**222** socket
**224** end opening
**226** blood pressure sleeve or cuff
**228** socket opening
**232** rubberized peripheral guard or bumper member
**234** stepped portion
**236** gap
**240** ribbon spring
**242** axially displaceable shaft member
**246** contained diaphragm
**248** indicating member
**250** circumferential channel
**260** gage housing
**264** upper housing portion
**268** narrowed lower housing portion
**270** engagement end
**271** end opening
**272** circumferential channel
**274** movement mechanism
**276** bottom surface
**280** rubberized guard member
**284** radially extending portion
**285** rubberized shim
**286** air gap
**288** air gap
**289** O-ring
**290** axially extending portion
**292** movement mechanism
**294** gage housing
**296** gage housing
**297** threaded end
**298** inlet port
**299** bottom opening

**300** port
**302** cap
**304** opening
**305** tubular member
**306** gage housing
**307** pneumatic bulb
**308** opening
**309** output end
**310** inlet port
**320** socket
**324** sleeve
**328** interior
**340** blood pressure measuring apparatus
**344** sleeve
**348** gage housing
**352** barb or port
**356** pneumatic bulb
**360** tubing
**364** check valve
**368** sleeve portion
**372** sleeve portion
**375** patient
**376** hook and loop fastener portion
**380** artery index marker
**384** indicia
**388** indicia

It will be readily apparent to those of ordinary skill in the field that other variations and modifications are possible within the spirit and scope of the invention as defined by the following appended claims.

We claim:

**1**. A blood pressure measuring device comprising:

a device housing having an upper portion and a lower portion, said lower portion including at least one engagement end that is directly couplable to an inflatable blood pressure sleeve to permit direct fluid communication between the interior of said device housing and the interior of said inflatable sleeve without hoses or tubing.

**2**. A pressure measuring device as recited in claim **1**, wherein said engagement end includes at least one circumferential channel for reducing the transmission of shock or impact loads to a movement mechanism retained within said housing.

**3**. A pressure measuring device as recited in claim **2**, wherein at least one circumferential channel is disposed on a bottom surface of said engagement end.

**4**. A pressure measuring device as recited in claim **2**, wherein at least one circumferential channel is disposed along an axial portion of said engagement end.

**5**. A pressure measuring device as recited in claim **1**, including said inflatable blood pressure sleeve, said sleeve having a receiving portion for directly receiving said engagement end, said receiving portion having an opening which permits fluid communication between the interior of the sleeve and the interior of the housing.

**6**. A pressure measuring device as recited in claim **1**, including a movement mechanism disposed within said housing and shock absorbing means for preventing the transmission of certain shock and impact loads to the movement mechanism, said shock absorbing means including means for creating a discontinuous path for said shock and impact loads.

**7**. A pressure measuring device as recited in claim **6**, wherein said shock absorbing means includes a peripheral bumper mount onto the exterior of said housing, said bumper having a periphery including at least one extending portion extending beyond said periphery, said extending portion including at least one gap region defining a buffer for absorbing a shock or impact load applied thereto.

**8**. A pressure measuring device as recited in claim **7**, wherein said at least one extending portion of said peripheral bumper extends axially above a viewing window attached to said upper portion of said housing.

**9**. A pressure measuring device as recited in claim **7**, wherein at least one extending portion of said peripheral bumper extends radially outward from the periphery of said bumper.

**10**. A pressure measuring device as recited in claim **6**, wherein said shock absorbing means includes at least one circumferential channel in said lower portion.

**11**. A pressure measuring device as recited in claim **10**, wherein said at least one circumferential channel is disposed in said engagement end.

**12**. A pressure measuring device as recited in claim **11**, wherein said circumferential channel is cut into a bottom surface of said engagement end.

**13**. A pressure measuring device as recited in claim **11**, wherein said circumferential channel is cut adjacent to a depending end of said engagement end.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 6,796,186 B2
DATED : September 28, 2004
INVENTOR(S) : Lia et al.

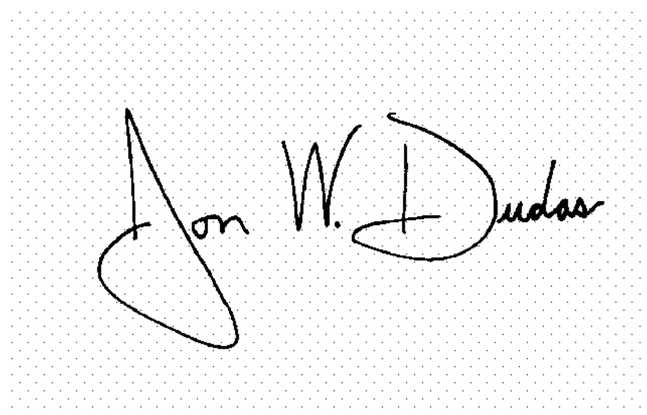


It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 16,
Line 21, change "mount" to -- mounted --.

Signed and Sealed this

Eighteenth Day of January, 2005



JON W. DUDAS
*Director of the United States Patent and Trademark Office*